Fenestrate Bryozoans with Large Apertural Form in the Carboniferous of Eastern Australia

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Study of Australian Carboniferous cryptostome fenestrate bryozoans has revealed that the number of rows of zooecial apertures per branch is transitional between species of *Fenestella* Lonsdale and *Polypora* M'Coy and is thus not necessarily the best basis for generic distinction. Apertural studies have demonstrated that simple fenestrate apertures fall into two size distributions with the larger diameter forms bearing a wide, low, peristomal collar in association with an operculum-like covering which bears a central boss-like projection. Species belonging to this group include most Australian Carboniferous forms previously referred to *Polypora* together with several two-rowed species which, otherwise, would normally be assigned to *Fenestella*. To separate these large apertural forms, two very closely related genera have been erected, *Australopolypora* gen. nov. and *Australofenestella* gen. nov., the former containing the multi-rowed species and the latter the two-rowed species.

Six species have been assigned to *Australopolypora* of which two are new: *Australopolypora rawdonensis* and *Australopolypora keppelensis parvula*. Seven species have been referred to *Australofenestella*, four of which are new: *Australofenestella brookeri, Australofenestella trevallynensis, Australofenestella* (?) *keepitensis,* and *Australofenestella stroudensis minuta*.

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INTRODUCTION

Previously described species of fenestrate bryozoans with three or more rows of apertures per branch, from the Carboniferous strata of eastern Australia, have all been placed in *Polypora* M'Coy (1844) without generic comment, obviously because this broadly defined genus was the only available taxon suitable for their reception. In total, eight such species have been described, five by Crockford (1947, 1949) and three by Campbell (1961).

The original diagnosis of *Polypora* (M'Coy 1844) required these fenestrate forms to have "three to five rows of apertures per branch, apertural peristomes which were never raised and non-poriferous dissepiments". These broad generic limitations were not strictly observed even by M'Coy who in the same paper described *Polypora verrucosa* M'Coy, in which the peristomal collars were strongly elevated (*vide* Miller 1963). It is thus not surprising that several of the above Australian species, which also exhibit strong peristomal exsertion, were placed by their authors in *Polypora*.

Over the long interval since M'Coy's diagnosis of *Polypora* was first published, it has been common practice to place regular fenestrate species, with non-poriferous dissepiments, into either *Fenestella* or *Polypora,* depending for the primary generic assignment almost entirely upon the number of rows of zooecial apertures per branch. Effectively, this aspect has assumed a weighting in taxonomy considered to be out of proportion to its importance for reasons given below. The relatively few species which have escaped this rigid dichotomy have depended upon the presence of some exotic

structural aspect, as can be found in various contemporary genera such as *Archimedes* Owen 1838, *Hemitrypa* Phillips 1841 and *Semicoscinium* Prout 1859.

Because of the virtually uncontrolled addition of many hundreds of species to *Fenestella* and *Polypora,* both broadly-defined genera have become totally unwieldy, impractical units for which only tentative efforts have been made in more recent times to devise some scheme of subdivision. With respect to the genus *Polypora,* the only major attempt at a key classification has been made by Russian palaeontologists who, as a result of their experience over some forty years, have based their grouping of species largely upon the number of rows of zooecia per branch, thus extending the style of demarcation between *Fenestella* and *Polypora* to the various species of *Polypora* with higher numbers of zooecial rows. Australian experience with a limited Carboniferous-Permian sample would suggest that this method can have direct stratigraphic relevance but at the same time it obscures some of the more basic morphological and genetic relationships which may lead to a more satisfactory subdivision.

Revised diagnosis of POLYPORA *M'Coy.* Appreciating the problems accompanying the unrestricted growth of *Polypora,* Miller (1963) re-described M'Coy's type material with the object of establishing a suitable standard for subsequent investigations. This emended generic diagnosis appears to have been written largely with the morphology of the type species in mind. In this respect it is rather restrictive in some morphological aspects, variations of which may be considered legitimately to fall within the limits of the genus. In particular, apart from the regular multi-rowed fenestrate features, *Polypora* is additionally re-defined as having (a) non-carinate branches; (b) regularly spaced, elevated nodes situated on the centreline of the branch; (c) hexagonal-polygonal zooecial bases arranged side by side on a flat basal plate; (d) a microstructure of tubules in the branch wall surrounding apertural margins and forming cores of nodes.

Australian Carboniferous species do not readily conform with some of these requirements for the following reasons.

Nodes, if developed at all, are scattered in a relatively haphazard fashion over the branch surface being placed adjacent to the proximo-central rim of an aperture in any row. There is a tendency to approach a vaguely central arrangement in a number of the species but none of them has "regularly spaced, elevated nodes situated on the centreline of the branch", the lack of which, given the current assessment of nodal function, is not considered to be sufficient reason for their exclusion from the genus.

In addition, the Australian material is preserved only as external and internal moulds with an absence of primary skeletal remains and hence the inclusion of tubular microstructure as an essential aspect becomes an impractical requirement. It is perhaps relevant to comment that an apparent lack of data on both nodes and microstructure in *Polypora marginata* M'Coy did not deter Miller (1963) from regarding it as a legitimate member of the revised genus.

As a possible alternative to the key classification of the Russian school, Miller suggested that further subdivision of *Polypora* could ultimately be based upon the following features: (a) presence or absence of nodes on the obverse of the branches; (b) arrangement of these nodes with respect to a central carina; (c) organization and location of the zooecial chambers in relationship to the 'basal plate'.

Apparently this suggested scheme was intended to result in new genera/subgenera, for the absence of nodes and the presence of a median carina would appear to be incompatible with his emended diagnosis of *Polypora.*

Over the decade since these suggestions were put forward, ideas on the importance of nodes have changed, a situation foreshadowed by Miller (1963, p.168).

Personal experience with Australian fenestrates appears to downgrade nodal distribution to the species or even varietal level, and it is difficult to justify any greater importance in taxonomy. Tavener-Smith (1973) has also questioned the validity of Miller's revised diagnosis regarding nodal occurrence and has rejected the requirements as unwarranted and over-restrictive.

Morphological Considerations

Having questioned the conventional relationship between *Fenestella* and *Polypora* and finding little else in the definition of either genus that is convincingly diagnostic, a further search was made for other features which could be of some value. An intensive morphological and statistical treatment was made of approximately 300 specimens including all type specimens of Australian Carboniferous species previously referred to either *Fenestella* or *Polypora*. This study has demonstrated predictably that much more attention should be given to individual zooecial characteristics. Whilst inter- and intra-zooecial variation is obviously basic in all descriptions, zoarial details have tended to dominate taxonomic studies at the generic/specific level almost to the exclusion of individual zooecial details. Historically, it has been easier, largely because of indifferent preservation, to record such items as zooecial spacing rather than to delineate the characteristics of individual chambers. In more recent years, most authors have realized the need to include zooecial characteristics and such items as the basal outline of zooecial chambers now form a common component of most new descriptions.

The following observations on morphological details have arisen from the present study:

Number of zooecial rows per branch. The conventional method of subdivision of species between *Fenestella* and *Polypora* on the basis of either two or three (and more) zooecial rows per branch was found to be increasingly impractical for Australian Carboniferous fenestrates. There exists a trend for two-rowed species, commonly assigned to *Fenestella,* to develop a third row of apertures prior to each branch bifurcation throughout the Carboniferous interval. Low zonal species have no pre-bifurcation apertures, mid-zonal species normally have one or two additional pre-bifurcation apertures and by the late Carboniferous there are commonly at least five or six and often more apertures arranged in a very distinct third row which extends for a considerable distance back towards the previous branch division. Since dominantly three-rowed species, normally placed in *Polypora,* commonly have a reduction to two rows of apertures for some distance immediately post-bifurcation, it is readily apparent that these tendencies lead to species which are obviously neither two- nor three-rowed in character (Fig. 3, 9). This problem of generic separation has already been cited by Campbell (1961) in the case of *Fenestella*? *altinodosa* Campbell where after doubtfully assigning the species to *Fenestella,* this author concluded that "perhaps it would be equally well placed in *Polypora*" (Campbell, 1961, p.459), a change which has now been proposed herein for other morphological reasons.

Many previous authors have noted the undoubtedly polyphyletic nature of both *Fenestella* and *Polypora* but none appears to have questioned the validity of using the number of apertural rows as a primary generic indicator. Based upon the present study of Australian species, it is suggested that at least some of the present taxonomic difficulties stem from this assumption. The change from two to three rows of apertures would appear to be a transitional one which does not seem to have been discussed previously with sufficient clarity. Excellent support for this transitional change comes from the genus *Septatopora* (Engel, 1975), where other highly diagnostic morphological features result in this one genus containing a group of species which progressively

change from two to four or five zooecial rows per branch over the duration of the Carboniferous Period.

Zooecial apertures. The most significant information to emerge from the present investigation was that zooecial apertures could be assigned to three compact varieties as outlined below:

1. Fenestellid type — a simple, circular aperture with a narrow peristomal rim, the degree of exsertion of which was from weak to moderate depending upon the obverse branch profile. Mean apertural diameter was in the range of 0.08-0.14mm. The group contained no apparent internal apertural structures and included most but not all Carboniferous species previously referred to *Fenestella* by Australian authors. Further subdivision of this group seems quite possible when coupled with additional morphological features.
2. Polyporid type — a large, simple, circular or oval aperture with a very broad peristomal collar which may be either entire (Fig. 2, 5) or open proximally in a horse-shoe shape (Fig. 1, 4). Both conditions can be observed in the one specimen. External moulds of all members of the group reveal the presence of an operculum-like lid over the aperture. This cover bears either an elevated perforation or a spine-like projection, the exact nature of which is not evident in this form of preservation (Fig. 1, 7). The structure is usually placed in the centre of the lid but can be eccentric in some cases (Fig. 3, 8). Rare specimens have been observed to bear minute septa-like projections around the margin of the aperture as recorded in the type species *Polypora dendroides* M'Coy by Miller (1963). Mean apertural diameter is between 0.14-0.23mm. Species belonging to this group include most of the Australian Carboniferous forms previously referred to *Polypora* together with a small group of uncommon species which in all other aspects would have been reasonably placed in *Fenestella*.
3. Septatoporid type — a circular, strongly exserted to stalked aperture with a thin, high, calice-like peristome. Within the aperture there are eight vestibular septa radiating from a small central orifice. Mean apertural diameter is between 0.07-0.13mm. Species of this group were previously placed in either *Fenestella* or *Polypora* depending upon the number of rows of zooecial apertures per branch. Apart from the apertures, other morphological aspects of this group leave little doubt of its separate status which has been elaborated elsewhere (Engel, 1975).

With reference only to the fenestellid and polyporid types, it is significant that there is a separation of apertures into two size ranges with the larger forms bearing a low, wide, peristomal collar coupled with an operculum-like covering over the orifice. It is also important that this separation does not conform with the conventional generic demarcation, based upon the number of rows of zooecial apertures per branch.

The fact that some apertures bear traces of up to sixteen, weak, septal projections would support the contention (Engel, 1975) that there is an undoubtedly close relationship between the polyporids and the new genus *Septatopora* Engel.

Zooecial chamber outline. The use of this feature as a diagnostic aspect for fenestrate genera is not without considerable risk of error. Wass (1968) has demonstrated that chamber outline is very sensitive to the exact level at which it has been recorded relative to the 'basal plate' of the specimen. Therefore, the use of random tangential thin sections for the identification of shape must remain a hazardous process, unless all shape changes have been recorded by serial sectioning.

Morozova (1974) has expressed great confidence in the diagnostic value of chamber shape by using it with several other mesh characteristics to fragment the

genus *Fenestella* (s.l.) into fourteen new genera. The present study does not entirely support the method adopted because of the difficulty in quantifying the actual shapes observed. When a chamber is studied as a three-dimensional internal mould, the distinction between triangular, trapezoidal and pentagonal shapes becomes a function of the branch width and the extent to which the chamber has been exposed down the sides of the branch. It is possible to recognize all three shapes on different branches within the one colony, given variable branch widths and different amounts of stripping of the outer calcareous layers. Thin sections cut at varying levels may record all of the above shapes, terminating with a bean-shaped outline when the section is deep enough to intersect the distal extension of the vestibule which leads to the obverse external aperture.

Experience with Australian material would suggest that much more intensive serial sectioning of fenestrate species is necessary before zooecial chamber shape can be applied as a reliable diagnostic feature. There is no doubt, however, that the feature has a role to play in future classifications of fenestrate species.

Nodes. In the species with three or more rows of apertures, described in this paper, nodes are frequently lacking. In the few cases where they are present, they occur randomly in any row being situated adjacent to the proximo-central rim of a particular aperture (Fig. 1, 8 & 9). This forms an interesting contrast to the contemporary *Septatopora* genus where the nodes are located on the distal rim of the apertures. Due to the width of the peristomal collar in the polyporids, it is not uncommon to see the node fused into the margin of the collar (Fig. 1, 8). The point to be noted is that there is a very close relationship of each node with a particular aperture and that there is not the development of a regular central row of nodes as recorded in the type species. Nodes in the dominantly two-rowed species described in this paper follow a regular, linear, nodal pattern when developed.

Modes of preservation. One of the central difficulties experienced in working with fenestrate species concerns variation in the modes of preservation of specimens.

Eastern Australian Carboniferous material is almost entirely preserved as external and internal moulds, with a consequent lack of primary skeletal material. Whilst this effectively prevents the preparation of thin sections, it undoubtedly provides excellent preservation of all external characteristics coupled with useful internal reconstructions of the original zooecial chambers.

The few silicified specimens extracted from local limestones have a worn, open skeletal appearance which compares very badly with the surface details available from moulds. This is possibly due to incomplete replacement or post-depositional abrasion, for the criticism is not true of this style of preservation in other regions.

A major problem arises in comparative studies because of different modes of preservation. Many Russian species are illustrated only with figures of thin sections which have been made at unspecified levels within the zoarium. It is impossible to compare these with the fine surface sculpture available from moulds. Comparative work is therefore reduced to the level of mesh comparisons which are, in themselves, insufficient for positive diagnosis in many cases. Undoubtedly these constraints of preservation have led to much duplication in the published literature.

Taxonomy

Biologically, it would seem that the morphological details and dimensions of individual zooecia may have more relevance than the number of them that can be packed into an ever expanding branch width. This opinion needs substantiation from

other workers since many older publications are deficient in this type of data, making literature comparisons very inconclusive.

Pending wider consideration of the classification value of individual zooecial details as proposed in this paper, a relatively conservative taxonomic approach has been adopted. Instead of grouping all the species within one genus, two new genera are proposed namely *Australopolypora* gen.nov. and *Australofenestella* gen.nov. In the former, all multi-rowed, non-carinate species are grouped together into an evolving stream which permits reasonable comparison with the many existing species of *Polypora* M'Coy. Similarly, the dominantly two-rowed, carinate species are placed together in the second genus facilitating a ready comparison with species of *Fenestella* Lonsdale. Thus instead of being incompatible with the classical dichotomy based on rows of apertures, the new genera build on that basis and extend the definitions to include the apertural characteristics.

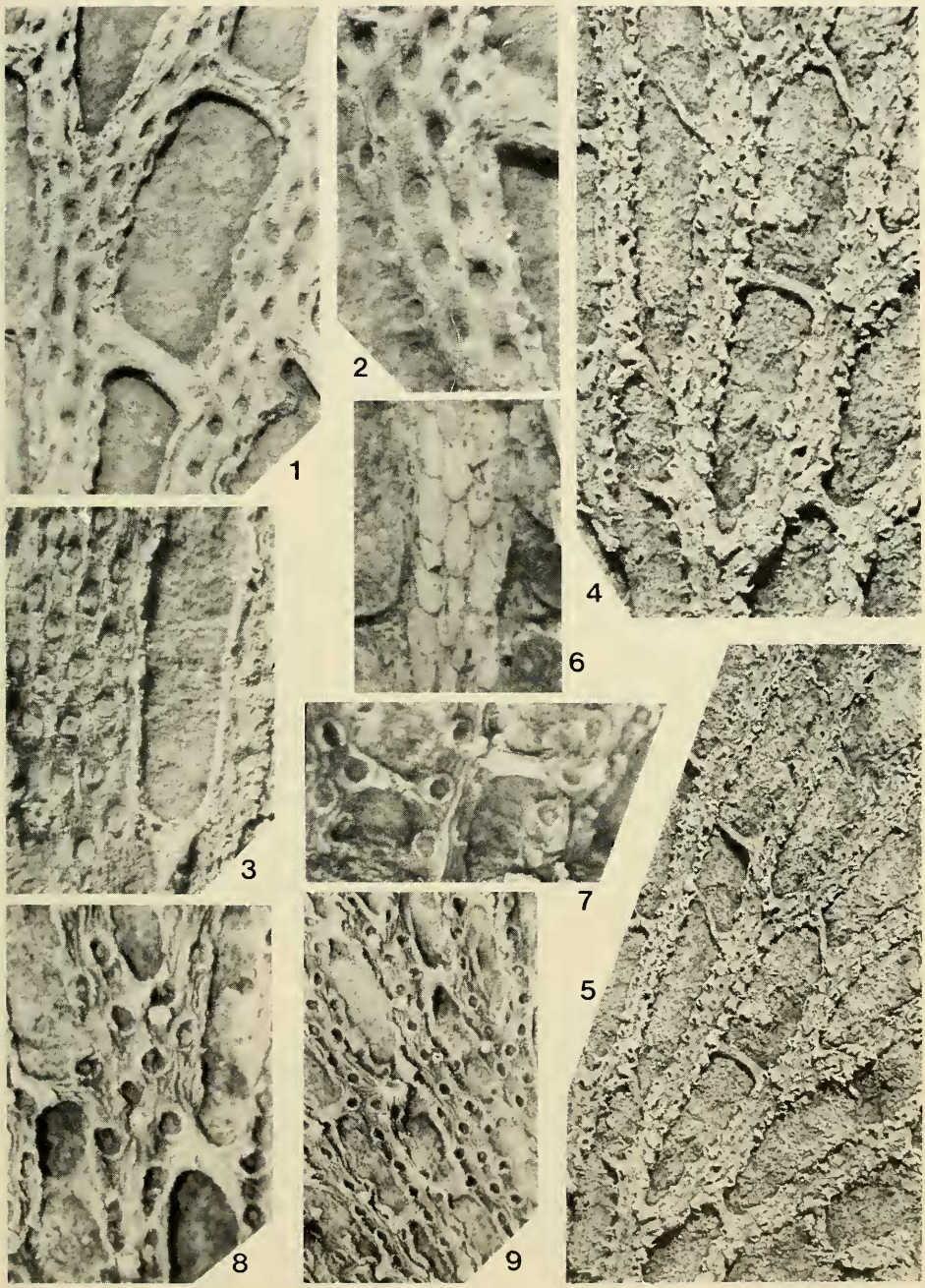
This compromise reduced the strength of the argument that like apertures should be grouped together but it is the only realistic course to adopt in the confused field of fenestrate bryozoan taxonomy. It must be stressed however that the new genera exhibit a much closer relationship than the nomenclature would suggest.

Reluctance to make major changes in the present generic status flows from the fact that the eastern Australian Carboniferous occurrence of fenestrate species is very restricted and is not necessarily representative of world-wide distribution. The present review of this fauna has revealed, after contractions by synonymy, a current total of fifteen species of *Fenestella,* seven species of *Australofenestella,* six species of *Australopolypora* and nine species of the new genus *Septatopora* (Engel, 1975) together with less common examples of *Archimedes, Hemitrypa* and *Semicoscinium*. On the basis of such a small sample it is unwise to propose major taxonomic shifts. However, the morphological trends evident in this pilot study of a relatively uncomplicated fauna could possibly have wider implications for the considerably larger and more diverse faunas in other parts of the world.

Abbreviations. All abbreviations used in the statistical treatment of fenestrate mesh are of standard form as cited in Engel (1975, p.577).

Repositories. Catalogued specimens have their number prefixed by the letter 'F', preceded by the following Museum coding:
QU = Queensland University; QGS = Queensland Geological Survey; NEU = University of New England; NU = University of Newcastle; SU = University of Sydney.

Fig. 1. (All except 6 prepared from latex casts.)
1-3. *Australopolypora palenensis* (Crockford). 1, 2, obverse surface showing wide, distally-inclined apertures with distinct, low, peristomal collars of similar orientation, QUF62187, locality Mt. Barney, x20, x30 respectively. 3, obverse surface showing similarly arranged apertures and peristomes, QUF32248, locality Ridgelands (188848), x20.
4-5. *Australopolypora rawdonensis* sp.nov. 4,5, obverse view of paratype showing horseshoe-shaped peristomes arranged in a fan-like form across the branch, NUF2345, locality NUL258, x15, x10 respectively.
6-9. *Australopolypora altinodosa* (Campbell). 6, reverse view showing shape and arrangement of internal moulds of three rows of zooecial cells, NEUF4708A, locality NUL9, x20. 7-9, obverse views of holotype illustrating: two-three zooecial row development; large open apertures with a boss-like projection on operculum; pseudo-carinal ornament in two-rowed branches; and large, broken, ribbed, surface spines, NEUF4708A, locality NUL9, x20, x20, x10 respectively.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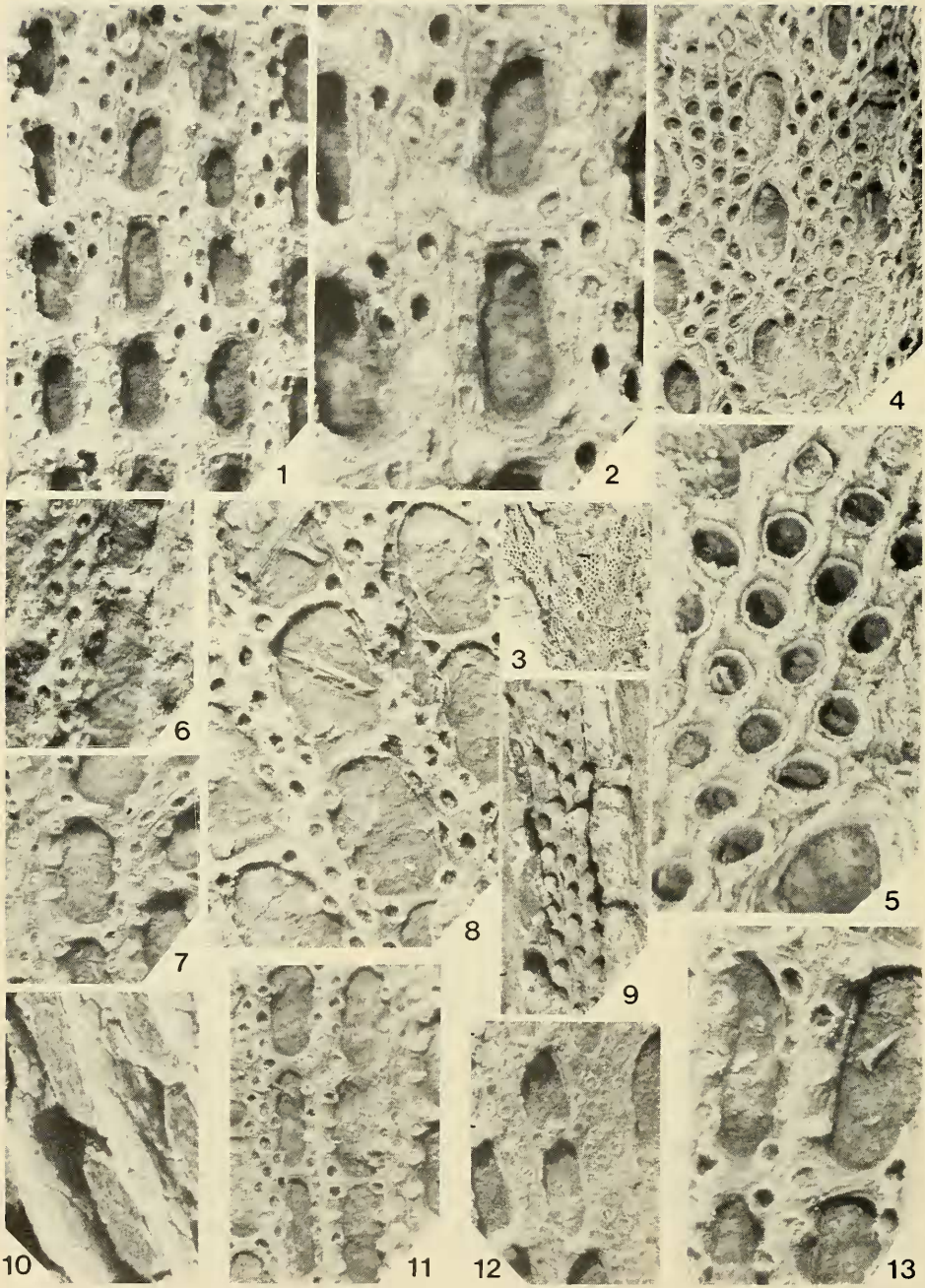
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Fossil localities. Where appropriate, localities are given by their number from the University of Newcastle Locality Index (NUL). Localities not in that index are given in full detail in the text. NUL9 — 3km east of Booral, N.S.W. (Campbell, 1961); NUL39 — Cameron's Bridge, Rouchel Brook, N.S.W. (Crockford, 1947); NUL258 — Barrington, N.S.W. (Cvancara, 1958); NUL454 — Isaacs Formation, Booral, N.S.W. (Campbell, 1961); NUL472 — Ridgelands 1 mile Military Map (Grid Reference 194827), Queensland (Fleming, 1969); NUL514 — Rawdon Vale, N.S.W. (Cobark 1:31680 Grid Reference 739454); NUL529 — Bonnington Formation, Trevallyn, N.S.W. (Roberts, 1965).

Photographic methods. Most specimens are preserved as internal or external moulds from which blackened latex casts were prepared for photographic purposes. These casts were then whitened with a layer of ammonium chloride before being photographed with a camera attached to a stereobinocular microscope.

SYSTEMATIC DESCRIPTIONS

Order CRYPTOSTOMATA Shrubsole & Vine 1882

Family FENESTELLIDAE King 1850

Genus *AUSTRALOPOLYPORA* gen.nov.

Type species. A. palenensis (Crockford) (= *Polypora palenensis* Crockford, 1949).
Diagnosis. Unifoliate or funnel-shaped fenestrate expansions comprising a uniform mesh of radiating, straight or gently sinuous, usually non-carinate branches joined by regular, non-poriferous, transverse dissepiments; zooecial apertures in three or more rows on obverse branch surface with increase and reduction in number of rows at branch bifurcations; apertures with low, broad, entire or horseshoe-shaped peristome, scarcely raised above the branch surface; apertures with an operculum which bears a raised boss; nodes, if developed, situated on the proximo-central rim of an aperture; reverse surface may bear spiny projections; both obverse and reverse branches may be smooth, granular or longitudinally striate.
Geological range. Late Visean — Permian.
Remarks. The distinctive apertural form and nodal development of this genus set it apart from the polyphyletic genus *Polypora* M'Coy.

Fig. 2. (All except **9** & **10** prepared from latex casts.)
1-2. *Australopolypora keppelensis parvula* subsp.nov. **1, 2,** obverse surface of holotype showing large, circular apertures with strong peristomal collars. Note nodal development and regular mesh, QUF32296, locality Ridgelands (194827), x20, x40 respectively.
3-5. *Australopolypora scalpta* (Campbell). **3-5,** obverse surface of holotype showing close packing of the large, circular apertures. Peristomal collars are depressed below branch level, NEUF4720B, locality NUL9, x3, x10, x30 respectively.
6-13. *Australopolypora neerkolensis* (Crockford). **6,** obverse surface of holotype, QUF25005, locality Mt. Barney, x10. **7, 11, 13** obverse surface illustrating low, peristomal collars surrounding wide apertures and sinuate longitudinal branch ornament. Note extended development of two zooecial rows after branch bifurcation, QUF10893, locality Ridgelands (265791), x10, x10, x20 respectively. **8,** obverse surface of specimen QUF10892, x10, locality. Ridgelands (265791). **9, 10,** obverse view of eroded specimen showing erect vestibules leading up to the external apertures; and reverse view of zooecial cells showing irregularly pentagonal to elongate rhomboidal form, QUF43162, locality Yarrol (QUL2654), x10, x15 respectively. **12,** obverse view of specimen which has been flattened during preservation, NEUF5667, locality NUL390, x10.

Australopolypora rawdonensis sp.nov.
Fig. 1, 4-5

Diagnosis. Coarse form with wide branches and narrow dissepiments forming a rectangular mesh; zooecia in three or four rows per branch with five to nine apertures per fenestrule; apertures oval, with horseshoe-shaped peristomes arranged in a fan-shaped arrangement across each branch.

Description. Zoarium: Fan-shaped, being composed of radiating branches of unknown orientation; maximum radius 35mm. *Obverse surface:* (a) *Branches.* Very wide (m.BW 0.56mm), straight or broadly curved; branch cross section circular to slightly oval, commonly deflated; ornament of longitudinal, sinuous, pustulose ridges which meander around and between zooecial apertures. (b) *Dissepiments.* Narrow to medium width (m.DW 0.16mm) with only slight expansion at branch junctions; level with or below branches; ornament or ridges continuous on to branches. (c) *Fenestrules.* Sub-rectangular to rectangular; coarse, irregular, fan-shaped mesh; fenestrule openings equal to or greater than branch width resulting in an open meshed appearance; long, wide fenestrules (m.FL 2.71mm; m.FW 1.24mm). (d) *Carina.* Absent. (e) *Nodes.* Absent; a few specimens have rare, large, distant, irregularly spaced spines of presumed attachment significance. (f) *Zooecial apertures.* Medium size, oval (m.max.ZD 0.17mm); surrounded by a strongly pustulose, moderately elevated, horseshoe-shaped peristome, open on the proximal margin; aperture closed by a poorly-preserved, centrally-perforated plate. Oval-shaped apertures in central rows with long axis parallel to branch length; marginal rows with long axis at 45° to branch length, with peristome gap facing centre of branch, or drawn out into a proximally-directed club-shape. Apertures alternate in adjoining rows with strong marginal indentation of fenestrules but without dissepimental stabilization; zooecia in three or four rows per branch with increase to five pre-bifurcation and decrease to three post-bifurcation; apertures moderately spaced (m.Z-Z 0.37mm) with from 5 to 9 zooecia per fenestrule (m.Z/F 7.3).

Reverse surface. (a) *Form.* Round branches joined by level or depressed, narrower dissepiments; reverse normally deflated; ornament of fine, longitudinal ridges comparable with those of the obverse surface; several strong spines developed at base of zoarium. (b) *Zooecial bases.* Oval bases arranged in non-overlapping rows.

Material. Holotype NUF2343a/b (NUL258); Paratypes NUF2344, 2345, 2347, 2349a/b (NUL258); NUF2353 (NUL514); Others NUF2346, 2348 (NUL258); NUF2350, 2351, 2352, 2354, 2355 (NUL514).

Remarks. No other Carboniferous species of *Australopolypora* has been found with a comparable apertural arrangement. Pustulose, horseshoe-shaped peristomes of similar form can be found at a lower stratigraphic level in such species as *Fenestella allynensis* Roberts (1965). The specific name is derived from the locality of Rawdon Vale, N.S.W.

Stratigraphy. Of major significance is the fact that *A. rawdonensis* is the first development of a three-four rowed species in the Australian Carboniferous sequence. It is found to be of common occurrence in the *Rhipidomella fortimuscula* zone at various localities in the Stroud-Gloucester Syncline, N.S.W. This stratigraphic distribution would indicate that *Australopolypora* first appeared in the Australian record in the mid-late Visean in marked contrast to the much earlier Northern Hemisphere distribution of *Polypora* M'Coy.

Australopolypora palenensis (Crockford, 1949)
Fig. 1, 1-3

1949 *Polypora palenensis* Crockford, pp.427-8, text fig. 12.
1972 *"Polypora" palenensis* Crockford; Fleming, pp.7-8, pl.3, figs. 1-3.

Revised diagnosis. Coarse form with very wide branches and large sub-oval to rectangular fenestrule openings; zooecia in three to four rows per branch, five to nine apertures per fenestrule; apertures circular, distant, inclined distally with proximal rim level with branch and distal rim depressed below branch level.

Revised description. Zoarium: Fan-shaped, composed of radiating branches of unknown orientation; maximum radius 40mm. *Obverse surface:* (a) *Branches.* Very wide (m.BW 0.60mm) straight or broadly curved in an irregular pattern due to frequent bifurcation; cross-section circular to oval, but commonly deflated into a broad strap-like form; zooecial rows separated by faint longitudinal meandering ridges; interapertural spaces and sides of branch with similar sculpture. (b) *Dissepiments.* Slender to wide (m.DW 0.23mm); narrow forms have only slight expansion at branch junction; wide forms expand continuously from centre to branch junction resulting in variably-shaped fenestrules. (c) *Fenestrules.* Sub-oval to rectangular; coarse, irregular, fan-shaped mesh; fenestrule openings large, resulting in an open meshed appearance; long to very long, wide fenestrules (m.FL 3.1mm; m.FW 1.37mm). (d) *Carina.* Absent. (e) *Nodes.* Absent. (f) *Zooecial apertures.* Medium size, circular (m. ZD 0.14mm), but frequently deformed during preservation; peristome entire, uniform, low, but well developed, and inclined distally; apertures closed by a poorly-preserved, perforated plate. Zooecial chambers elongated proximally, with a distally-directed vestibule meeting the branch at a low angle, resulting in the apertural face also being distally inclined to the branch surface; this is achieved by having the proximal rim level with, or above the branch surface and the distal rim depressed into the branch in a suitable cavity; resultant longitudinal obverse branch profile is a sawtooth pattern along each row of apertures. Fenestrule indentation slight or lacking; apertures not stabilized with respect to dissepiments; zooecia in three to four rows per branch with increase to five or six pre-bifurcation, and decrease to two or three post-bifurcation; apertures distantly spaced (m.Z-Z 0.48mm) with from five to nine zooecia per fenestrule (m.Z/F 6.4).

Reverse surface: (a) *Form.* Rounded branches joined by narrower dissepiments generally situated below branch level; reverse commonly deflated; ornament of fine longitudinal striations normally obscured by a thin smooth overgrowth. (b) *Zooecial bases.* Oval with little or no overlap between rows.

Material. Holotype QUF25008, Neerkol Series, Por. 127V/202, Par. Palen, Mt. Barney, Queensland; Paratype QUF25009 (type area); Others QUF62187, QGSF10931a/b (type area); QGSF10909 (Neerkol Fm., Malchi Creek, Ridgelands 1 mile map ref. 265791); QUF32248 (Neerkol Fm., Ridgelands 1 mile map ref. 188848).

Remarks. Fleming (1972) amplified the brief description of Crockford (1949), and gave the first photographic illustration of the species. However, he omitted to emphasize the apertural inclination and its resultant obverse branch profile which, apart from the very coarse mesh, is the most diagnostic feature of the species. The low angle of intersection of the straight vestibule and branch surface has resulted in a distinctive form which has not been observed in any of the other described species of *Australopolypora.*

Small apertural septa noted by Fleming (1972) have not been observed in the material available to the writer. Some external moulds display a ring of very strong pustules around the peristome which are possibly equivalent to the tubules surrounding the apertures of *P. dendroides* M'Coy.

Stratigraphy. The majority of specimens of *A. palenensis* (Crockford) come from the Mt. Barney region or from Malchi Creek, near Rockhampton, Queensland. Lack of

recognition of the species in other areas is probably a product of the brief description and inadequate type material upon which the species was based.

Though not common in New South Wales, it has been found in the present study at a number of localities where it was not listed by previous authors. In all cases it occurs with a *Levipustula levis* fauna, but because of an inability to establish the time equivalence of many of the occurrences of this fauna, it is not possible to assign *A. palenensis* a restricted range as Fleming (1972) has done for its occurrence in Queensland.

Australopolypora altinodosa (Campbell, 1961)

Fig. 1, **6-9**

1961 *Fenestella* (?) *altinodosa* Campbell, pp.458-9, pl.57, figs. 2a,b.

Revised diagnosis. Medium to coarse fenestrate with wide branches arranged in a sub-rectangular mesh; zooecia in two to three rows per branch, with three to four apertures per fenestrule; apertures large, distant with strong circular peristome; nodes very large and distantly spaced; branch ornament of strong ribbing.

Revised description. Zoarium: Small, fan-shaped fragment of unknown orientation; maximum radius 20mm. *Obverse surface:* (a) *Branches.* Straight, wide (m.BW 0.46mm), commonly deflated; obverse branch profile centrally elevated but without median carina; ornament of strong, longitudinal ribbing, about six in number with central rib becoming carina-like on two-rowed branches; some ribs continuous and sinuate, others only developed interaperturally; ribs on lateral slope of branch bear fine pustules; rib number rises to twelve pre-bifurcation. (b) *Dissepiments.* Medium width (m.DW 0.17mm); centrally straight with moderate expansion at branch junction; situated level with branches; ornament of strong ribs continuous on to branches. (c) *Fenestrules.* Elongate sub-rectangular to sub-oval; medium length and width (m.FL 1.75mm, m.FW 0.93mm). (d) *Carina.* Absent; role assumed by central prominent, sinuate, surface rib; early development of three rows of zooecia results in two such ribs over considerable distances. (e) *Nodes.* Very large, circular, oval-based with a diameter of 0.16-0.24mm; nodes very tall (≥0.4mm), generally sloping distally with neither obvious termination nor superstructure evident; ornament of longitudinal ribbing; distantly spaced (m.N-N 0.90mm), irregularly placed along a central row; nodes on three-rowed branches are situated between the apertures of the central row but seldom on the centre line of the branch. (f) *Zooecial apertures.* Circular to slightly oval, large (m.ZD 0.20mm), surrounded by a prominent, moderately-exserted peristome; each aperture closed by an axially-perforated, domed, diaphragm-like plate; apertures alternate in lateral and median rows and are not stabilized with respect to the dissepiments; marginal rows with little or no fenestrule indentation; zooecia in two rows per branch with three rows developing up to 5mm prior to bifurcation; apertures distantly spaced in each row (m.Z-Z 0.49mm) with from three to four zooecia per fenestrule (m.Z/F 3.6).

Reverse surface: (a) *Form.* Branches with broadly semi-circular profile tapering slightly from obverse; dissepiments level with or slightly below branches; ornament of fine, straight, longitudinal ribbing. (b) *Zooecial bases:* Elongate, irregularly pentagonal in marginal rows with the central row being rhomboidal in shape.

Material. Holotype NEUF4708A, Booral, N.S.W. (NUL9).

Remarks. Campbell (1961) noted several unusual features about this species which caused him to have doubts about its correct generic category. His final choice of doubtfully grouping it with *Fenestella* Lonsdale is at variance with other morphological aspects, here considered to place it more appropriately with *Australopolypora*.

Unusual features noted by Campbell (1961) include: very high nodes placed randomly on any part of the obverse branch surface, an absence of any clearly defined median carina, and the very early development of a third row of apertures up to 5 mm prior to each branch bifurcation.

In addition to these aspects, the apertural form of the species is considered to align it closely with other Australian Carboniferous species of *Australopolypora*. It shares with them a very large circular aperture which is surrounded by a broad peristomal collar of distinctive appearance. It also exhibits the flat, centrally perforated plate which is presumed to have closed the aperture.

As discussed earlier, these apertural features are considered to be of greater diagnostic value than the number of rows of apertures which does not clearly group the species with either of the available generic categories. No comparable species has been described in available literature.

Stratigraphy. The single known specimen was described by Campbell (1961) from just below the main *Levipustula* bed at Booral, N.S.W., a locality considered to be of early Westphalian age. No other comparable material has been recovered from the type locality or elsewhere.

Australopolypora neerkolensis (Crockford, 1949)
Fig. 2, 6-13

1949 *P.neerkolensis* Crockford, pp.426-7, text-fig. 10.
1962 *P.neerkolensis* Crockford, Campbell, pp.46-7, pl.13, figs. 1a-d.
1964 *P.neerkolensis* Crockford, Maxwell, p.58, [non pl. 13, figs. 8-9].
1964 *P. neerkolensis* Crockford, Hill & Woods, p.c.8, pl.C4, figs. 3-4.
1972 *P.neerkolensis* Crockford, Fleming, pp.5-6, pl.3, figs. 4-7.

Revised diagnosis. Medium-sized form with very wide branches and wide dissepiments set in a variable mesh of oval to sub-rectangular fenestrules; zooecia in three rows per branch, with three to five apertures per fenestrule; apertures large, circular, with centrally-perforated domed plate; carina lacking; nodes irregularly developed.

Revised description. Zoarium: Sub-parallel branches set in a narrowly-radiating fan-shaped zoarium of unknown orientation; maximum radius 50mm. *Obverse surface:* (a) *Branches*. Very wide (mBW 0.64mm); branch cross-section oval but commonly flattened by deflation, ornament of fine pustules with variable development of longitudinal ridges between apertures; ornament strong on branch sides; two-rowed branches can have a raised central rib of carina-like form. (b) *Dissepiments*. Medium to broad (m DW 0.27mm); outline highly variable with some expanding continuously from their centre to the branch junction, whilst others are narrow and straight without expansion; most dissepiments are inclined rather than vertical in position; situated level with or just below branches; ornament of strong ribbing continuous on to the branch surface. (c) *Fenestrules*. Oval to sub-rectangular; medium-sized mesh of variable appearance; some specimens have fenestrule openings equal to or narrower than branches resulting in a closed mesh appearance whilst others have thin extended dissepiments which produce an open-meshed form; medium length, medium to wide fenestrules (m FL 1.74mm; m FW 1.10mm). (d) *Carina*. Absent in all but short post-bifurcation segments where a central prominent rib can develop a carina-like appearance between the two rows of apertures which are present in that region. (e) *Nodes*. Irregularly developed nodes occur on some specimens, being placed adjacent to, or forming part of, the apertural peristome on its proximal side in any apertural row. (f) *Zooecial apertures*. Large (m ZD 0.20mm), circular to oval, being surrounded by a prominent, entire peristome; apertures crossed by an arched, centrally perforated plate which in external moulds bears a raised central boss which

can rise above the level of the peristome; usually three rows per branch with increase to four or five pre-bifurcation and decrease to two or three rows post-bifurcation; apertures distantly spaced in each row (m Z-Z 0.44mm) with from three to five apertures per fenestrule (m Z/F 4.3); apertures in adjoining rows very closely packed with less than a zooecial diameter separating them diagonally; apertures may indent fenestrule margin according to the degree of branch deflation, and are not stabilized with respect to dissepiments.

Reverse surface: (a) *Form.* Narrowly-rounded branches joined by level or slightly depressed dissepiments; thin outer surface smooth beneath which are developed numerous fine, longitudinal striations. (b) *Zooecial bases.* Elongate oval to elongate rhomboidal; irregularly pentagonal in two-rowed segments.

Material. Holotype QUF25005, Por.127V/202 Par. Palen, Mt. Barney; (Paratype — Specimen QUF24999 listed by Crockford (1949) as a paratype is actually a specimen of *Septatopora pustulosa*). Other specimens mentioned by Crockford are missing; Others QGSF10929-10930, 10934 (Type locality); QGSF10892-10894, Malchi Creek, Stanwell; QUF32189 Neerkol Creek, Stanwell; QUF32290, NUF2367-2368 (NUL472); QUF43162, 43199 Yarrol (Maxwell, 1964); NEUF5656-5670 Oaky Creek (Campbell, 1962).

Remarks. Crockford (1949) based this species on a poorly-preserved holotype which has resulted in considerable confusion with later determinations. Better-preserved material described by Campbell (1962) and Fleming (1972) has resulted in a clearer understanding of the species.

In the present study, considerable doubts have been entertained with respect to the conspecific nature of all the material placed by Fleming (1972) in this species. Features which exhibit most variation include: (a) *Mesh form.* Most specimens have broad, curved dissepiments associated with a closed-mesh appearance. A few specimens (QGSF10892-4) have thin, extended dissepiments with a resultant open mesh. This variation could be due to meshwork changes within a complete zoarium, but larger specimens from other regions do not support such a proposal. (b) *Zooecial apertures.* Well preserved branches have a round profile with moderately-exserted apertures which indent the fenestrule margin, thus having a somewhat similar appearance to that of *Septatopora pustulosa* (Crockford) with which it was confused by both Crockford (1949) and Maxwell (1964). Many other specimens have strongly-deflated, strap-like branches in which the apertures are also flattened. The difference in appearance between these two states of preservation requires a very detailed inspection for transitional stages between the two extremes. (c) *Apertural diameter.* Open-meshed specimens (QGSF10892-4) have a consistently larger zooecial diameter than that of most other specimens. The combination of this feature plus the mesh form may be significant, but, as it is possible to observe transitional stages, some uncertainty persists as to the correct specific designation. The holotype is most certainly too badly preserved to enable a positive diagnosis of the morphological limits of the species.

Stratigraphy. A. neerkolensis occurs in the *Levipustula levis* zone at various localities in New South Wales and Queensland.

Queensland specimens have been recovered from various levels in the Neerkol Formation (Stanwell), from the Poperima Formation (Yarrol), and from the type locality at Mt. Barney. New South Wales specimens have been recorded from the Kullatine 'Series' at Oaky Creek (Campbell, 1962) and from several localities of the *Levipustula levis* assemblage in the Gloucester-Bulahdelah region.

Fleming (1972) suggests that *A. neerkolensis* is restricted to the early portion of the *Levipustula levis* zone in the Neerkol Formation and its equivalents. Re-examination of specimens placed by Fleming (1960, 1969) in *Polypora* cf. *woodsi* from

the *Auriculispina levis* zone, together with extra material collected from that zone (QUF32290, NUF2367, NUF2368) leave little doubt that they belong to *A. neerkolensis*. In these circumstances it would appear that this species is a long ranging one extending through the whole of the Neerkol Formation (2100m).

Australopolypora scalpta (Campbell, 1961)
Fig. 2, 3-5

1961 *P.scalpta* Campbell, pp.461-2, pl.60, fig.11.

Revised diagnosis. Medium-sized form of closely-meshed appearance; composed of very wide branches and very small, oval fenestrules; carina and nodes absent; apertures large, oval, medium-spaced being located in branch depressions from which a thin, entire peristome rises almost to branch level; apertures usually in four rows per branch.

Revised description. Zoarium: Gently-radiating branches of unknown orientation; maximum radius 12mm. *Obverse surface:* (a) *Branches.* Very wide (m.BW 0.86mm), generally flattened in cross-section; ornament of sinuous, longitudinal ridges between apertural rows; surface pustulose. (b) *Dissepiments.* Very wide (m.DW 0.74mm); strongly expanded at branch junction; level with branches; ornament of some surface ribbing, more evident on sides of both branches and dissepiments. (c) *Fenestrules.* Oval; very closely-meshed form dominated by wide branches and small fenestrules, resulting in a very closed mesh appearance; medium length, medium to wide fenestrules (m.FL 1.56mm; m.FW 1.14mm); actual fenestrule opening is approximately 0.8mm long by 0.3mm wide. (d) *Carina.* Absent; three to five linear rows of apertures are separated by prominent, sinuous ridges. (e) *Nodes.* Absent. (f) *Zooecial apertures.* Large, slightly oval (long diameter m.ZD 0.23mm); surrounded by a narrow, raised, entire peristome which does not quite rise to the level of the longitudinal, interzooecial, sinuous ridges, due to the moderate depression of the apertures below branch level; apertures in four rows per branch with increase to five pre-bifurcation and decrease to three post-bifurcation; apertures moderately to distantly spaced (m.Z-Z 0.41mm) with from three to four zooecia per fenestrule (m.Z/F 3.8); apertures in adjoining rows closely crowded, being separated diagonally by a distance of about half the zooecial diameter; fenestrules not indented by apertures which are also not stabilized with respect to the dissepiments.

Reverse surface: (a) *Form.* Flattened to weakly-rounded branches joined by broad, level dissepiments; branches bear weak, finely pustulose striations usually obscured by secondary thickening. (b) *Zooecial bases.* Broadly flattened, elongate-hexagonal or oval in outline.

Material. Holotype NEUF4720A/B, Booral, N.S.W. (NUL9).

Remarks. This highly distinctive species is readily recognizable by its depressed apertures and peristomes which are situated below the prominent, longitudinal, sinuous ridges separating the zooecial rows. No other comparable form has been observed in the literature.

The holotype remains the only known specimen despite intensive collecting at the type locality.

Stratigraphy. The type locality was recorded by Campbell (1961) as being above the main *Levipustula levis* bed at Booral, New South Wales (NUL9).

Australopolypora keppelensis (Crockford, 1946)

1946 *P. minuta* Crockford, p.133, text fig. 9.
[non] 1932 *P. minuta* Deiss, p.28. [*vide* Crockford, 1962].

1962 *P. keppelensis* Crockford, p.840.

1968 *P. keppelensis* Crockford, Wass, p.47, pl.12, fig.2.

Diagnosis. Medium to fine form; zooecia in three rows with three zooecia opposite each fenestrule; surface ornamented by discontinuous ridges and grooves between the apertures, and by a few small nodes.

Holotype. QUF7974a, Lakes Creek Beds (*Trachypora* horizon behind quarry), Rockhampton, Queensland. (Artinskian).

Geological age. Late Carboniferous — late Permian.

Australopolypora keppelensis parvula subsp.nov.
Fig. 2, 1-2

Diagnosis. Medium to fine species; regular mesh with wide branches and dissepiments forming uniform oval fenestrules; carina absent; nodes irregularly disposed adjacent to some apertures; apertures large, closely spaced in three rows per branch; peristome wide being either entire or proximally open; apertures closed by a flat, centrally perforated plate.

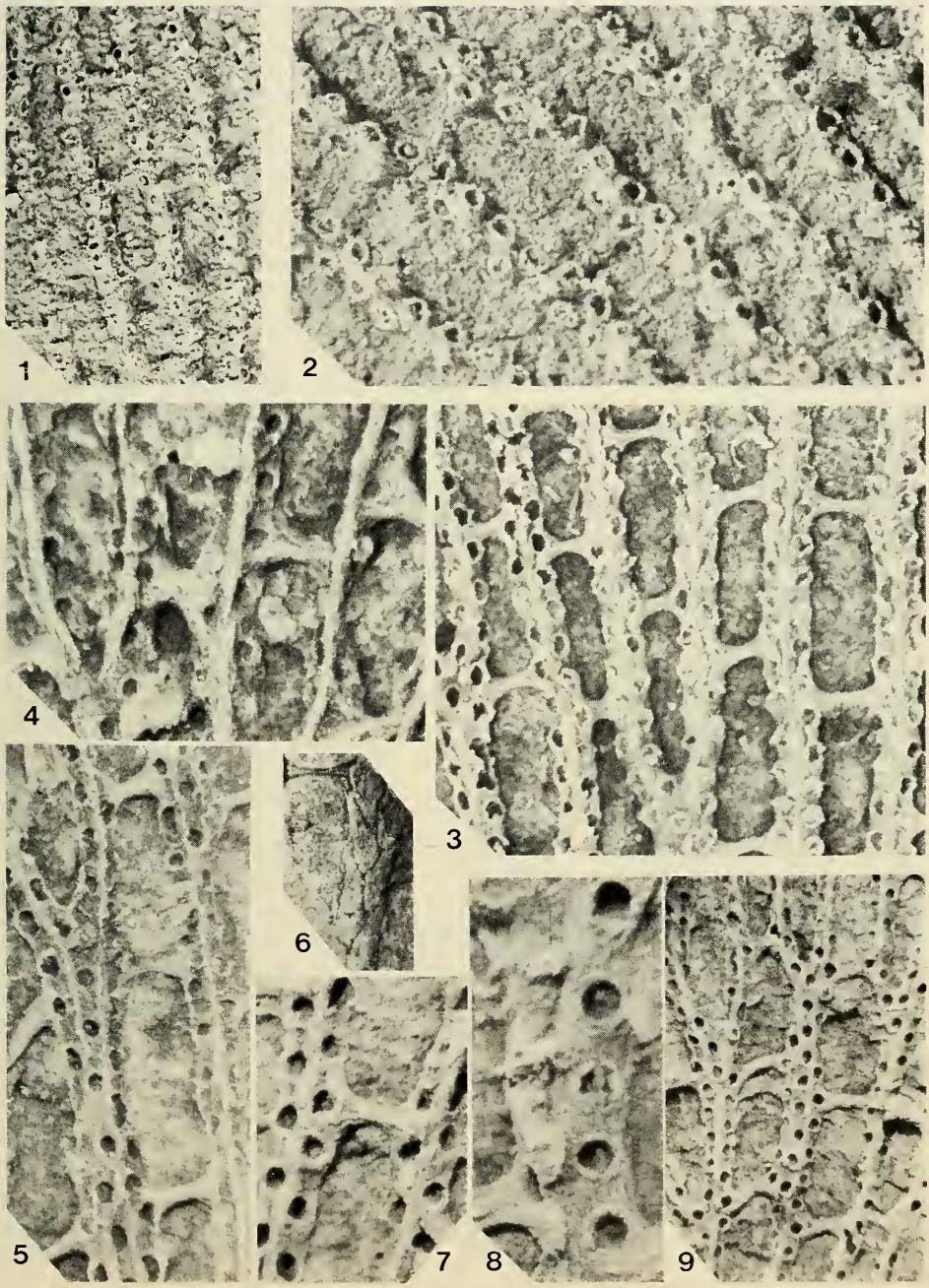
Description. Zoarium: Moderately-radiating, sub-parallel branches in flat expansion of unknown orientation; maximum radius 22mm. *Obverse surface:* (a) *Branches.* Medium to wide (m.BW 0.41mm) with circular cross-section becoming oval at bifurcation; ornament of sinuous ribbing between and around the apertures. (b) *Dissepiments.* Wide (m.BW 0.23mm), expanded from centre in a semicircular curve to the branch junction; level with branches; ornament of strong ribbing continuous on to branches. (c) *Fenestrules.* Oval to sub-oval; mesh fine to medium-sized and very regular; fenestrule openings and branch width of similar dimensions producing a very uniform mesh appearance; fenestrules short and of medium width (m.FL 0.84mm; m.FW 0.64mm). (d) *Carina.* Absent. (e) *Nodes.* Numerous, round (diam.ca. 0.1mm), bluntly-pointed, irregularly-developed nodes associated with apertures in all zooecial rows, but tending towards a near central arrangement; absent over large areas, but when present usually placed adjacent to the proximal rim of an aperture. (f) *Zooecial apertures.* Medium to large (m.ZD 0.15mm), circular to oval in outline; peristome prominent, slightly raised and faintly pustulose; peristome can be entire, but more frequently has a horseshoe-shaped appearance, with the proximal margin being smoothed over in a lip-like form; each aperture covered by a centrally-perforated plate; apertures in three rows per branch with increase to four pre-bifurcation, and decrease to two post-bifurcation; fenestrule indentation slight, and apertures not stabilized with respect to the dissepiments; apertures directed perpendicular to the curvature of the branch with some marginal elevation of the peristomes in the lateral rows; branch surface depressed between apertures which are closely spaced (m.Z-Z 0.26mm) with from two to four zooecia per fenestrule (m.Z/F 3.2); apertures in adjoining rows very close being diagonally separated by about half a zooecial diameter.

Fig. 3. (All except 6 prepared from latex casts.)

1-2. *Australofenestella brookeri* sp.nov. **1, 2,** obverse surface of holotype showing large apertural form in a two-rowed species. Some apertures exhibit a central axial boss, NUF2541, x15, x30 respectively.

3. *Australofenestella stroudensis minuta* subsp.nov. **3,** obverse surface of holotype showing large apertural form and a low, central, nodose carina, NUF2396, locality NUL258, x20.

4-9. *Australofenestella stroudensis stroudensis* (Campbell). **4,** obverse surface of specimen previously referred to *Fenestella anodosa* Campbell, NEUF4701, locality NUL9, x20. **5,** obverse surface of holotype of *F. anodosa,* NEUF4700C, locality NUL9, x20. **6,** reverse surface of holotype of *A. s. stroudensis* showing arrangement of zooecial cells, NEUF4704B, x15, locality NUL9. **7-9,** obverse surface of holotype of *A. s. stroudensis* illustrating the large apertural form and distinct development of a strong boss or spine on the operculum covering the apertures, NEUF4704B, x20, x30, x10 respectively.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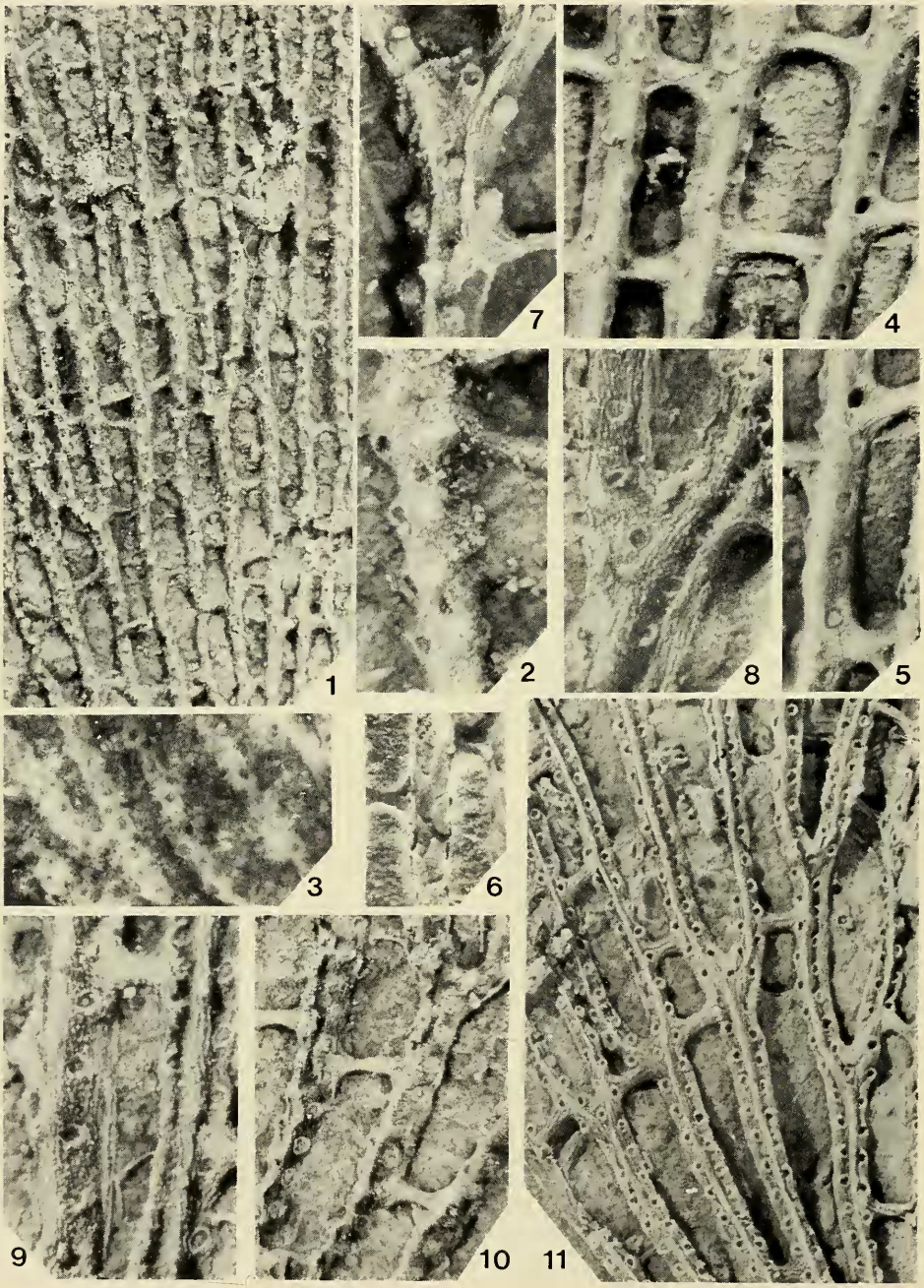
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Reverse surface: (a) *Form.* Rounded branches joined by medium-width dissepiments slightly below branch level; ornament of a smooth, thin, outer layer covering longitudinal striations. (b) *Zooecial bases.* Irregularly pentagonal in lateral rows with a rhomboidal form in the central rows.

Material. Holotype QUF32296 (NUL472); Paratypes QUF32297, QUF32295 (NUL472).

Remarks. The specimens which form the basis of this new subspecies were collected by Fleming (1960) who gave an unpublished description of them under the open nomenclature of *Polypora* cf. *keppelensis* Crockford. The same material was listed again in this form in Fleming (1969). Fleming considered his material to be identical with *A. keppelensis* except for their consistently shorter fenestrule length.

An examination of measurements made upon the type specimens of *A. k. keppelensis* and the specimens of *A. k. parvula,* given in Table 1, reveals that there are significant differences in fenestrule length and width, dissepiment width and zooecial spacing with consequent discrepancies in the associated space counts. Apart from these mesh differences, both groups display considerable similarity in apertural form and arrangement with some apertures of both having a proximal break in the peristome with an associated lip-like structure.

Based upon the present material from the late Carboniferous Neerkol Formation as well as that from the Artinskian Lakes Creek Beds (Crockford, 1946) and from younger Permian beds in the Bowen Basin (Wass, 1968), the following stratigraphic changes support the erection of the new subspecies: (a) there is a noticeable change in mesh dimensions from *A. k. parvula* in the Neerkol Formation to *A. k. keppelensis* from the Lakes Creek Beds with only slight further change in the later Permian specimens. (b) With the mesh change, the fenestrule form also changes from the regular oval shape in *A. k. parvula* to sub-oval to sub-rectangular in *A. k. keppelensis* from the Lakes Creek Beds to a normally sub-rectangular form in the younger *A. k. keppelensis* from the Bowen Basin. (c) Nodes of irregular distribution are very common in *A. k. parvula,* becoming rarer and finally absent in the Permian representatives.

Stratigraphy. All specimens of *A. k. parvula* were collected by Fleming (1960) from the locality NUL472 (QGSL1000) as geologically described by Fleming (1969). This location, east of the Ridgelands-Stanwell Road, occurs in the top 300m of the Neerkol Formation and has been assigned a late Carboniferous age.

A. k. keppelensis Crockford (1946) was originally described from the Lakes Creek Beds, east of Rockhampton. Because of breaks in the sequence, the section

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Fig. 4. (All except 3 & 6 prepared from latex casts.)

1-3. *Australofenestella(?) keepitensis* sp.nov. **1, 2,** obverse surface of holotype illustrating the close, irregular nodal distribution and the occasional development of a third central row of apertures. Note nodal variation (whiter marks) in 2 with both linear and zig-zag form. **3,** obverse fragment of holotype showing three-rowed zooecial arrangement, NEUF7466A, locality NEUL318, x6, x30, x10 respectively.

4-9. *Australofenestella malchi* (Crockford). **4, 5,** obverse surface of holotype showing large apertures, peristomal collars and large surface hemispherical depressions, QUF24952, locality Malchi Creek, x20, x20 respectively. **6,** reverse view of zooecial chambers, QUF10903, locality Malchi Creek, x20. **7,** obverse surface of specimen previously referred to *Fenestella cerva* Campbell. Note carinal development at branch bifurcations, NEUF4705H, locality NUL454, x20. **8, 9,** obverse views of holotype of *F. cerva* illustrating profile change as a result of deformation. Note boss-like projections within the apertures on **9,** NEUF4709A, locality NUL454, x20, x20 respectively.

10, 11. *Australofenestella cincta* (Crockford). **10,** obverse surface of deformed specimen showing strong boss-like structures within the peristome, NEUF4715E, locality NUL9, x10. **11,** obverse surface of well preserved specimen, QGSF10897, showing strong nodeless carina separating two rows of large apertures, locality Ridgelands (265791), x10.

connecting these two faunas is not known. On other faunal evidence, the Lakes Creek Beds were assigned an Artinskian age by Crockford, a determination supported by Kirkegaard, Shaw & Murray (1970).

Genus *AUSTRALOFENESTELLA* gen.nov.

Type species. Australofenestella malchi (Crockford) (=*Fenestrellina malchi* Crockford, 1949, pp.422-423, fig. 4)

Diagnosis. Unifoliate or funnel-shaped fenestrate expansions comprising a uniform mesh of radiating, straight or gently sinuous, weakly to strongly carinate branches joined by regular, non-poriferous dissepiments; large size zooecial apertures in two rows with variable increase in rows prior to bifurcation; apertures with low, broad, entire or horseshoe-shaped peristome raised only on branches with acutely triangular cross-section; apertures with an operculum which bears a raised boss; nodes vary from obsolete to blunt, widely-spaced cones arranged in a central row on the carina; obverse and reverse branch surfaces may be smooth, granular or striate.

Geological range. Carboniferous-Permian.

Remarks. The distinctive apertural form in this genus readily separates it from *Fenestella* Lonsdale. Features which separate it from *Australopolypora* include the number of apertural rows, the median carina and the different arrangement of the nodes.

Australofenestella brookeri sp.nov.
Fig. 3, 1-2

Diagnosis. Medium-sized form with medium-width branches forming a sub-oval to sub-rectangular, regular mesh; branches bear no distinct central carina but a central row of large, broadly cone-shaped, distantly-spaced, nodes; apertures occur in two rows with a third row appearing only in the fork at bifurcation; apertures large, close to medium-spaced with a low, wide, entire peristome; zooecial bases elongate triangular to irregularly pentagonal.

Description. Zoarium. Gently expanding fragments of unknown orientation; maximum radius 30mm. *Obverse surface:* (a) *Branches.* Medium width (m.BW 0.33mm) near straight; branch cross-section broadly rounded without carina; no ornament observed. (b) *Dissepiments.* Medium width (m.DW 0.17mm); dissepiments expand in a broad curve from their centre to the branch junction where they join just below branch level; ornament of moderate ribbing which continues on to branch sides. (c) *Fenestrules.* Sub-oval to sub-rectangular; medium-sized, moderately regular mesh (m.FL 1.49mm; m.FW 0.72mm). (d) *Carina.* Absent; some indistinct low ridging occurs between nodes. (e) *Nodes.* Wide-based, cone-shaped nodes which narrow rapidly to a fine point; distantly spaced (m.N-N 0.71mm) in a central row. (f) *Zooecial apertures.* Medium to large, circular (m.ZD 0.15mm); surrounded by a low, entire, broad, moderately raised peristome; apertures arranged in two rows with a third appearing only in the fork at each bifurcation; apertures alternate in adjoining rows and are situated on the broad obverse slope of the branch where they are directed with slight lateral inclination towards the fenestrule; they are not stabilized with respect to the dissepiments and have moderate fenestrular indentation; apertures close to medium-spaced (m.Z-Z 0.29mm) with from 4 to 6 zooecia per fenestrule (m.Z/F 5.1).

Reverse surface. (a) *Form.* Unknown. (b) *Zooecial bases.* Elongate triangular to irregularly pentagonal.

Material. Holotype NUF2541 (NUL39).

Remarks. Diagnostic aspects of this species include its apertural form and position, branch form and nodes.

The need to document these distinctive, rare elements of the Australian Carboniferous fenestrate fauna justifies the generally undesirable practice of erecting a new species based upon a single specimen.

The specific name honours a resident of the Rouchel Brook district, Mr B. Brooker.

A. brookeri shares with *A. stroudensis minuta* and *A. stroudensis stroudensis* the development of large cone-shaped nodes, wide, circular apertures, no carina, and a similar broad branch profile. Further, in order of stratigraphic appearance, *A. brookeri* has one aperture in the fork at branch bifurcation, *A. s. minuta* has two apertures and *A. s. stroudensis* can have between five and ten extra apertures in a third row prior to a branch division. This morphology would suggest that these three taxa form a lineage throughout the Carboniferous sequence.

Stratigraphy. The only known material has been discovered in the Waverley Formation at Cameron's Bridge, Rouchel Brook, where it is associated with a fauna of the *Pustula gracilis* subzone of the *Schellwienella* cf. *burlingtonensis* zone.

Australofenestella stroudensis (Campbell, 1961)

1961 *F. stroudensis* Campbell, p.458, pl.56, figs. 1a-c.

1961 *F. anodosa* Campbell, p.457, pl.57, figs. 3a-c.

Revised diagnosis. Fenestrate species with medium to coarse, regular mesh; carina low, poorly defined with moderate to distantly spaced nodes of variable form; two rows of apertures increase to three some distance before branch bifurcation; apertures large, with entire peristome; branch ornament of longitudinal ribbing; zooecial bases irregularly pentagonal.

Geological range. Late Visean-Westphalian.

Australofenestella stroudensis stroudensis (Campbell, 1961)
Fig. 3, 4-9

Synonymy. As above.

Revised diagnosis. Medium to coarse species with wide branches arranged in a regular mesh; carina low, ill-defined, with distant, poorly developed obsolete nodes; apertures in two rows per branch with the appearance of a third row, containing up to ten apertures, before bifurcation; apertures large, distant, with entire circular peristome; branch ornament of sinuous, pustulose ribbing; zooecial bases irregularly pentagonal.

Description. Zoarium: Expanding zoarial fragments of unknown orientation; maximum radius 60mm. *Obverse surface:* (a) *Branches.* Straight, wide (m.BW 0.45mm), commonly deflated; obverse branch profile centrally elevated with a low, ill-defined carina; ornament of sinuous, longitudinal, pustulose ribbing between and surrounding apertures. (b) *Dissepiments.* Medium width (m.DW 0.17mm); centrally straight with moderate expansion at branch junction; situated level with branches; ornament of coarse to fine ribbing which expands laterally on to branch sides. (c) *Fenestrules.* Sub-rectangular, medium to coarse, moderately regular mesh; fenestrules medium to long and wide (m.FL 1.91mm; m.FW 0.97mm). (d) *Carina.* Low, rounded to blunt keel of variable preservation due to frequency of branch deflation; it may appear as a high, bladed structure if branches are depressed on either side of this central plate or alternatively, if the whole branch is flattened, it may be barely apparent on the obverse surface; two carinae develop with the very early

appearance of a third row of zooecia before bifurcation; because of the very large apertures, the carina tends to be sinuate or resorbed by the apertures. (e) *Nodes.* Some regions on the type material display low, indistinct, rounded elevations which may be taken to represent an obsolete row of nodes. (N-N. ca. 0.60mm). (f) *Zooecial apertures.* Large, circular, prominent (m.ZD 0.19mm); slightly raised apertures surrounded by an entire peristome which may rise on to or replace the low carina; apertures arranged in two rows with a third row, containing from two up to ten apertures (max. length 5mm), appearing prior to each branch bifurcation; apertures alternate in adjoining rows and are partially stabilized with respect to the dissepiments; apertures placed on obverse branch surface, being either erect or gently inclined towards the fenestrule, unless distorted by preservation; fenestrular margin very slightly indented, if at all; apertures medium to widely spaced (m.Z-Z 0.43mm) with from 4 to 5 zooecia per fenestrule (m.Z/F 4.5). (g) *Additional features.* Zooecial diameter at the peristome is maintained vertically for the length of the vestibule, giving the appearance of a very wide, open aperture; at the base of this deep, erect vestibule the chamber turns in a sharp right-angle bend in the proximal direction, where it expands into an elongate zooecial chamber. A few branches display spherical depressions on the branch surface between apertures which may possibly represent the site of ovicellular development.

Reverse surface: (a) *Form.* Rounded branches joined by narrow, level dissepiments; bifurcations preceded by a very gradual spread in branch width associated with the obverse development of a third row of apertures; many branches exhibit deflation effects on the reverse; ornament of longitudinal striations on branches and dissepiments, partly obscured by overgrowth in proximal parts of the zoarium; some large anchoring spines occur near the base of a few zoaria. (b) *Zooecial bases.* Irregularly pentagonal.

Material. Holotype NEUF4704A/B (NUL9); Paratype NEUF4703 (NUL9); Others NEUF4700B/C, 4701 (NUL9).

Remarks. Detailed comparison of *A. stroudensis* (Campbell) and *A. anodosa* (Campbell) has revealed that most apparent differences are the result of the highly distorted state in which the type materials have been preserved.

Type specimens of *A. stroudensis* have been subjected to vertical compression which has produced a general flattening of the obverse surface. Specimens of *A. anodosa* have been deformed by lateral compression in addition to the vertical loading. Whilst general deflation of the branch has taken place, the carinal plate has not been crumpled so that it now appears as a high, usually inclined, bladed carina. On either side of this carina, the weaker apertural surface has collapsed into a channel located between the carina and the doubled-over side walls of the branch, which now appear as two lateral carinae. Dissepiments are generally undeformed, but are snapped off at the branch junction, and pushed up over the apertural surface or into the side of the branch. Restoration of the profile would result in a form indistinguishable from that of *A. stroudensis.*

Both species were originally described as being nodeless. However, intensive study has revealed traces of very poorly preserved, low nodes on a few branches, a conclusion already noted by Wass (1968, p. 83). In both cases it is apparent that the nodes were very close to obsolescence. The existence of stronger, but similar nodes upon the stratigraphically older *A. stroudensis minuta* would support this conclusion.

The only mesh variation between *A. anodosa* and *A. stroudensis* occurs in the zooecial spacing which is slightly greater in *A. anodosa.* This difference is not considered to be significant.

In strict order of appearance in the one paper, *A. anodosa* is the senior specific

name, but because it is considered inappropriate to apply this name to a species which does in fact bear nodes, *A. stroudensis* has been selected as the more suitable, available taxon.

Stratigraphy. All known specimens have been found associated with the *Levipustula levis* zone at Booral, N.S.W. (Campbell, 1961).

Australofenestella stroudensis minuta subsp.nov.
Fig. 3, 3

Diagnosis. Medium-sized fenestrate, with narrow branches arranged in a regular, open, sub-rectangular mesh; branches bear a low, ill-defined carina with small, moderately spaced nodes; apertures in two rows, with a third row appearing one or two apertures before bifurcation; apertures large, closely spaced with thin, entire peristomes; branch ornament of moderately developed longitudinal ribbing; zooecial bases irregularly pentagonal.

Description. Zoarium: Moderately expanding, laminar, zoarial fragment of unknown orientation; maximum radius 30mm. *Obverse surface:* (a) *Branches.* Straight, narrow (m.BW 0.29mm); branch cross-section rounded with a gentle slope on either side of an ill-defined carina; ornament of moderately developed ribbing or otherwise smooth. (b) *Dissepiments.* Narrow (m.DW 0.08mm); centrally straight with greatest expansion at branch junction; situated level with branches and ornamented with coarse ribbing which expands laterally on to branch sides. (c) *Fenestrules.* Sub-rectangular; regular, open mesh with fenestrules of medium length and width (m.FL 1.37mm; m.FW 0.72mm). (d) *Carina.* Low, rounded, ill-defined central carina, partly resorbed by apertural peristomes. (e) *Nodes.* Central row of small, circular or oval-based nodes with moderate spacing (m.N-N 0.44mm). (f) *Zooecial apertures.* Large, circular, prominent (m.ZD 0.17mm) slightly raised apertures surrounded by a thin, entire peristome which can replace portion of the carina; wide vestibular diameter is maintained until further expansion occurs into the zooecial chamber; apertures arranged in two rows per branch, with a third row appearing up to two apertures prior to branch bifurcation; apertures alternate in adjoining rows and are situated on the broad obverse slope of the branch, being directed upwards or with slight lateral inclination; apertures partly stabilized with respect to dissepiments and only with slight marginal indentation of the fenestrules; apertures closely spaced (m.Z-Z 0.30mm) with from 4 to 6 zooecia per fenestrule (m.Z/F 4.6).

Reverse surface. (a) *Form.* Broadly rounded branches joined by narrow, near level dissepiments; ornament of fine, longitudinal ribbing. (b) *Zooecial bases.* Irregularly pentagonal.

Material. Holotype NUF2396 (NUL258).

Remarks. The sub-specific name alludes to the diminutive size of this specimen as compared with that of *A. s. stroudensis.*

Principal differences at the subspecific level include: (a) *A. s. minuta* has an overall smaller mesh, with significant differences in most dimensions. Whilst size alone is not of major importance, the lack of intermediate material makes it unwise to group these specimens into a single taxon; (b) *A. s. minuta* has a regular, central row of small nodes not developed on *A. s. stroudensis,* where the nodes are either poorly preserved or vestigial in form; (c) *A. s. minuta* has fewer pre-bifurcation apertures than *A. s. stroudensis.*

Generally *A. s. minuta* is closely related to *A. s. stroudensis* but displays sufficient transitional differences between *A. brookeri* and *A. s. stroudensis* to justify its treatment as a separate subspecies. Differences between *A. s. minuta* and *A. brookeri* are noted in the description of the latter species.

Stratigraphy. This specimen has been collected from the Barrington area (NUL258) where it is associated with a *Rhipidomella fortimuscula* fauna (Cvancara, 1958).

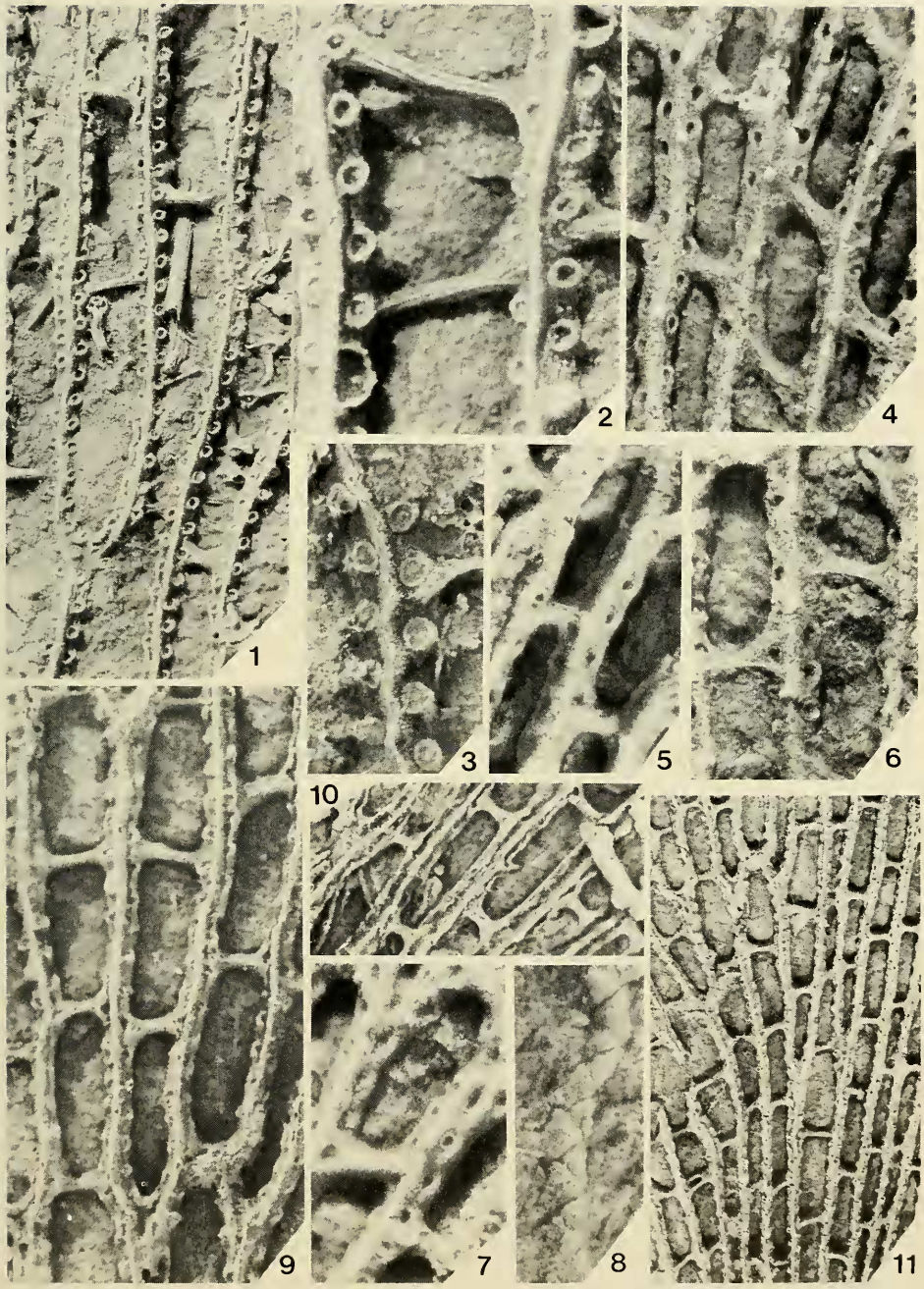
Australofenestella trevallynensis sp.nov.
Fig. 5, 4-8

Diagnosis. Medium-sized, irregular, crenulated fenestrate with narrow to medium width, straight or broadly curved, weakly carinate branches forming a rectangular to sub-rectangular mesh; nodes medium size, moderately to distantly spaced; apertures medium to large size, not stabilized, directed obversely or slightly sideways; zooecia in two rows with a third row appearing up to two apertures before bifurcation; zooecial bases elongate triangular/trapezoidal trending to irregularly pentagonal on wide branches.

Description. Zoarium: Expanding, crenulated fragments of unknown orientation; maximum radius 60mm. *Obverse surface:* (a) *Branches.* Narrow to medium width (m.BW 0.30mm), straight or slightly irregular; radiating proximally, sub-parallel distally; cross-section broadly tapered to rounded but frequently deformed; ornament of strong, pustulose, longitudinal ribbing often obliterated by smooth overgrowth. (b) *Dissepiments.* Narrow to medium width (m.DW 0.15mm); centrally straight with moderate expansion at branch junction; some junctions inflated to house an enlarged zooecium; ornament of strong ribbing with central rib having a carinate form. (c) *Fenestrules.* Rectangular to sub-rectangular; irregular mesh with fenestrules of medium length and width (m.FL 1.57mm; m.FW 0.73mm). (d) *Carina.* Moderately to weakly developed, low carina connecting elongated nodal bases; generally about one third of branch width. (e) *Nodes.* Medium-sized, pointed, circular nodes with elongated bases; medium to distantly spaced (m. N-N 0.59mm) in a central row. (f) *Zooecial apertures.* Medium to large (m. ZD 0.14mm); circular to slightly oval-shaped; one specimen has a few enlarged zooecia (ca. 0.2mm) located at branch-dissepiment junctions; peristome circular, slightly raised on fenestrular margin and covered with an operculum-like plate which bears a central boss; apertures in two unstabilized rows with a third row of one or two apertures prior to bifurcation; apertures closely spaced (m. Z-Z 0.31mm) with from four to six apertures per fenestrule (m. Z/F 5.1).

Reverse surface: (a) *Form.* Evenly rounded or slightly tapered branches joined by medium-width dissepiments; ornament of fine striations with weak pustules usually rendered smooth by overgrowth. (b) *Zooecial bases.* Elongate triangular/trapezoidal trending to irregularly pentagonal on wider branches.

Fig. 5. (All except 8 prepared from latex casts.)
1-3. *Australofenestella cincta* (Crockford). **1, 2,** obverse surface of neotype showing large mesh form and very high, nodeless carina; 2 illustrates the development of large hemispherical pits superimposed on some apertures, within which it is still possible to observe the boss-like projection, QGSF10898, locality Ridgelands (265791), x10, x25 respectively. **3,** obverse view of one branch showing the strong boss-like projections in each aperture, NEUF4715E, locality NUL9, x20.
4-8. *Australofenestella trevallynensis* sp.nov. **4-7,** obverse surface of holotype showing large apertural form, peristomal collars and an ill-defined carina with evenly spaced, distant nodes, NEUF6918, locality NUL529, all figs. x20. **8,** reverse of zooecial cells showing triangular-trapezoidal form, NEUF6908, locality NUL529, x20.
9-11. *Australofenestella macleayensis* (Campbell). **9,11,** obverse surface of holotype showing large apertures separated by a strong carina upon which the nodes are very difficult to observe, NEUF5738, locality NUL390, x10, x5 respectively. **10,** obverse surface of holotype of *A. crockfordae* (Campbell) showing the typical crushed appearance of the material placed in that species, NEUF4699A, locality NUL9, x10.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Material. Holotype NEUF6918a/b (NUL529); Paratype NEUF6908/6909 (NUL529); Others NUF2429a/b, 2433 (NUL258); NEUF6918, (?)6919 (NUL529).

Remarks. Features including carinal form, branch profile and apertural form display considerable variation in this species, largely as a result of structural deformation during preservation. Specimens from NUL258 (Barrington) tend to have little carinae, more exserted apertures and occasional enlarged zooecia whereas those from the type locality are more carinate and less exserted.

The specimens from NUL529 (Trevallyn) were formerly grouped by Roberts (1965) in *F. allynensis* Roberts. They can be readily separated from the latter species which has large, ear-like apertural hoods, rounded carinae, much closer nodes and irregularly pentagonal zooecial bases.

A. trevallynensis is quite similar to *F. gresfordensis* Roberts (1963) which is distinguished by its possession of much closer nodes; distinct, high-bladed carinae; weakly-hooded, proximally inclined apertures; and very distinctive, flanged, zooecial bases.

Stratigraphy. This species has been identified from the Trevallyn locality of Roberts (1965) in a formation containing an *Orthotetes australis* fauna. It has also been found in the *Rhipidomella fortimuscula* zone at Barrington (Cvancara, 1958), but not as yet in the intervening *Delepinea aspinosa* zone.

Australofenestella malchi (Crockford, 1949)
Fig. 4, **4-9**

1949 *Fenestrellina malchi* Crockford, pp.422-423, fig. 4.
1961 *Fenestella malchi* (Crockford) Campbell, p.460.
1961 *F. cerva* Campbell, pp.455-456, pl.59, figs. 1a-c.
1964 *F. malchi* (Crockford) Maxwell, p.38, pl.12, fig. 13.
1972 *F. malchi* (Crockford) Fleming, p.4, pl.2, figs. 1-3.

Revised diagnosis. Regular fenestrate with medium-width, straight branches forming a uniform sub-rectangular mesh; branches broadly rounded with distinct carina which bears large, circular, widely spaced nodes; apertures in two rows with a third appearing before bifurcation; apertures medium-sized, circular, not stabilized, with operculum-like plate bearing a central boss; ornament of pustulose striations; zooecial bases elongate, irregularly pentagonal.

Description. Zoarium: Gently to rapidly expanding fan-shaped fragments of unknown orientation; maximum radius 60mm. *Obverse Surface:* (a) *Branches.* Medium to wide (m.BW 0.40mm), frequently collapsed and distorted during preservation; branches sub-parallel to radiating in arrangement; branch cross-section rounded to triangular on either side of a sharply defined, broad carina; ornament of fine, wavy, pustulose striations. (b) *Dissepiments.* Medium width (m.DW 0.16mm), centrally straight, expanding only at branch junctions; ornament as on branches. (c) *Fenestrules.* Rectangular to sub-rectangular; regular mesh of medium length, medium width fenestrules (m.FL 1.63mm; m.FW 0.91mm). (d) *Carina.* Strong, massive, high carina varying from broad to sharp profile within one zoarium, the variation being a product of distortion during preservation; at bifurcation, carina swings on to one branch with a second, new carina commencing near a small node in the fork, or forming outside the third row of zooecia sometimes developed just before bifurcation. (e) *Nodes.* Large, circular nodes with elongate oval bases; distantly spaced (m. N-N 0.81 mm) in a single central row. (f) *Zooecial apertures.* Medium size, circular (m.ZD 0.14mm); surrounded by a low, circular peristome, best

developed on the fenestrular rim; each bears an operculum-like plate with a central boss; apertures distantly spaced (m. Z-Z 0.42mm) with from three to five zooecia per fenestrule (m. Z/F 4.0); apertures in two unstabilized rows per branch with a third row up to 1mm before branch bifurcation. (g) *Additional features.* Hemispherical depressions (0.8-0.9mm diam.) occur on obverse surface near base of zoarium.

Reverse surface. (a) *Form.* Rounded branches joined by medium-width dissepiments; branch width increases very close to bifurcation producing a distinctive tuning-fork shape; ornament of pustulose striations together with distally-directed irregular spines on a few branches. (b) *Zooecial bases.* Elongate, irregularly pentagonal.

Material. Holotype QUF24952 (Malchi Creek); Paratypes QUF24953 (Malchi Creek), QUF25006 (Por. 201-2, Parish Palen, Mt. Barney), SUF7432 (NUL9); Others QGSF10903, 10904 (Malchi Creek), NEUF4705H, 4709A, 4718, 4739 (NUL454).

Remarks. Deflation during preservation has caused much confusion with this species. The styles of deformation present are discussed with *A. s. stroudensis* (Campbell).

Campbell (1961) described two species *A. malchi* (Crockford) and *A. cerva* (Campbell) from Booral, N.S.W. and it is suggested in this paper that most of the differences between these two are a direct result of preservation. Distinguishing features listed by Campbell for *A. cerva* include large fenestrules, more zooecia per fenestrule, a more defined carina and peristomes (not recorded for *A. malchi*). The first two differences have been bridged in the present study by intermediate forms and the latter two are preservational aspects, rather than specific differences. Tall nodes recorded on *A. cerva* by Campbell have also been found in specimens of *A. malchi.* For these reasons, the two taxa have been contracted into *A. malchi* in the present description.

A. malchi is also similar to *A. macleayensis* (Campbell, 1961), the major differences being largely that of size of fenestrules, branches and nodal spacing. Since the present study has failed to produce transitional material, these two taxa have been retained in their present form.

Stratigraphy. A. malchi occurs in the *Levipustula levis* zone at Malchi Creek and Mt. Barney in Queensland and at several localities in the Stroud-Gloucester and Myall Synclines (including Booral) in New South Wales. Present information suggests that the species ranges throughout most of the brachiopod assemblage zone.

Australofenestella macleayensis (Campbell, 1961)
Fig. 5, **9-11**

1961 *F. crockfordae* Campbell, pp.457-458, pl.59, figs. 2a-b.
[non] 1960 *F. (Minilya) crockfordae* Burckle, p.1088.
1962 *F. macleayensis* Campbell, p.48, pl.11, figs. 11a-c.

Revised diagnosis. Fenestrate with coarse, regular, sub-rectangular mesh; straight, wide, broadly rounded branches with a high, rounded, well-defined carina which bears distant nodes; two rows of unstabilized apertures per branch with increase to three rows prior to bifurcation; apertures medium-sized, erect with entire peristome within which there is an operculum-like plate with a central boss; branch ornament of fine pustulose striations; zooecial bases elongate, irregularly pentagonal.

Description. Zoarium: Flat, slightly expanding fragment of unknown orientation; maximum radius 50mm. *Obverse surface:* (a) *Branches.* Straight, wide (m. BW 0.47mm), commonly deflated; profile broadly rounded with a sharply-defined central carina; ornament of fine pustulose striations. (b) *Dissepiments.* Medium to

wide (m. DW 0.18mm); centrally straight with gradual expansion to branch junction; ornament as for branches. (c) *Fenestrules*. Sub-rectangular, coarse, regular mesh; fenestrules long and wide (m. FL 2.62mm; m. FW 1.04mm). (d) *Carina*. High, prominent, well-rounded, medium to broad, being less than one third of the width of the branches; with deflation, carinae become much broader in profile; two carinae develop with the early appearance of a third row of zooecia before bifurcation. (e) *Nodes*. High, bladed nodes situated on the central carina; spacing very distant and irregular (m. N-N 1.10mm); nodes poorly preserved on holotype. (f) *Zooecial apertures*. Medium-sized, circular (m. ZD 0.15mm), with slightly raised peristome producing erect, cup-shaped apertures; apertures display an operculum-like plate with a central boss; apertures not stabilized; widely spaced (m. Z-Z 0.43mm) with from three to six and one half zooecia per fenestrule (m. Z/F 6.1) being arranged in two rows with a third row appearing up to 1.6mm pre-bifurcation.

Reverse surface. (a) *Form*. Rounded branches joined by rounded dissepiments less than half branch width; ornament of fine, close striae generally obscured by overgrowth. (b) *Zooecial bases*. Elongate, irregularly pentagonal.

Material. Holotype NEUF5738 (NUL390 — Oaky Creek, Kempsey); Others NEUF4698, 4699 (NUL9 — Booral).

Remarks. Campbell (1961) erected a new species *A. crockfordae* (Campbell) which is pre-occupied by *F. (Minilya) crockfordae* Burckle (1960) and therefore must be replaced. Campbell (1962) described a further new species *A. macleayensis* which in the opinion of Wass (1968, pp. 83, 85) and the present writer is specifically identical with *A. crockfordae* (Campbell). The former name has therefore been selected for this taxon.

Reasons for the contraction are based upon the following: Campbell (1962) noted that the two species were comparable, but decided that *A. crockfordae* (Campbell) was distinctive because of its large nodes and very wide carina. As *A. macleayensis* was described as being nodeless, this represented a significant difference. However, careful re-examination of the latter holotype reveals that it does have nodes which are difficult to observe because of their very poor preservation. When measured they have identical spacing with those of *A. crockfordae* (Campbell). Carinal differences between *A. crockfordae* (Campbell) and *A. macleayensis* are due to different modes of deformation during preservation as discussed in the remarks with *A. stroudensis* (Campbell). As a result, it becomes apparent that only one species is now required.

Stratigraphy. This species is known only from the *Levipustula levis* zone in New South Wales.

Australofenestella cincta (Crockford, 1949)
Fig. 4, 10-11; Fig. 5, 1-3

1949 *Fenestrellina cincta* Crockford, p.425, text-fig. 8.
1961 *Fenestella* cf. *cincta* (Crockford), Campbell, p.460.
1964 *F. cincta* (Crockford), Maxwell, p.38, pl.13, fig. 1.
1972 *F. (Bajoola) cincta* (Crockford), Fleming. p.4, pl.2, figs. 4-6.

Revised diagnosis. Coarse fenestrate with very wide, rapidly-bifurcating branches forming a coarse, irregularly rectangular mesh; branches with triangular profile, bearing a strong, very high, nodeless carina; apertures in two rows with no pre-bifurcation increase; apertures large, circular, erect, and of cup-like form with the peristome being raised on the fenestrular margin; branch ornament of distinctive, pustulose, longitudinal striations; zooecial bases very elongate, irregularly pentagonal.

Description. Zoarium: Narrowly radiating to sub-parallel, mature fragments of unknown orientation; maximum radius 40mm; branch bifurcation frequent. *Obverse surface:* (a) *Branches.* Straight to slightly wavy, sub-parallel; very wide (m. BW 0.55mm); rapid spread of branches after bifurcation followed by sub-parallel development has produced a distinctive 'tuning-fork' arrangement; cross-section triangular to sub-rounded, tapering steeply upwards to a very prominent central carina; ornament of fine to coarse, longitudinal, pustulose, sinuous ribbing. (b) *Dissepiments.* Medium to wide (m. DW 0.19mm); centrally straight with minor expansion at branch junction; situated at or just below branch level; ornament of prominent ribbing which is continuous on to branch sides. (c) *Fenestrules.* Very coarse, irregular mesh; high frequency of bifurcation, and the growth of dissepiments not always perpendicular to branches, disrupts an otherwise rectangular outline; fenestrules of variable dimensions; usually very long and wide with some fenestrules being very short (m. FL 3.39mm, O.R. 1.59-6.9mm; m. FW 1.23mm, O.R. 0.7-2.0mm). (d) *Carina.* Acutely triangular, very high, slightly sinuous median carina; considerably steeper than branch profile from which it is separated by a marked change of slope; carina continuous on one branch at bifurcation, showing a temporary loss of profile adjacent to the zooecial aperture in the fork, new carina on the other branch forms up from one of a group of prominent surface ribs located on the side of the branch, there being no obvious connection back to the primary carina. (e) *Nodes.* Absent. (f) *Zooecial apertures.* Large, circular (m. ZD 0.19mm) surrounded by an entire, strongly developed, exserted peristome; apertural profile low, adjacent to carina, but with maximum elevation on the fenestrular margin giving the aperture a cup-like form on the obverse slope of the branch; zooecia arranged in two rows with no pre-bifurcation increase except for one aperture being located on the fork at each branch division; apertures alternate in position in adjoining rows being not stabilized with respect to the dissepiments and displaying very slight fenestrular indentation; apertures closed by operculum-like plates, each of which bears a variably-placed, spine-like projection; apertures very widely spaced (m. Z-Z 0.49mm) with from 3 to 12 zooecia per fenestrule (m. Z/F 7.0). (g) *Additional features.* Occasional resorbed apertures are surrounded by a semi-circular pit located on the branch between the carina and a narrow semi-circular ridge which extends beyond the edge of the branch (0.36-0.42mm long by 0.24-3mm wide). The aperture in the base of the pit has a very reduced peristome but still has the opercular plate present. One aperture was observed to have a small spherical sac obscuring it. An ovicellular function has been postulated.

Reverse surface: (a) *Form.* Rounded branches joined by small, medium-width level dissepiments; branch surface longitudinally ornamented with fine, pustulose ribbing; similar, but coarser, ribbing occurs on the dissepiments. (b) *Zooecial bases.* Very elongate, irregularly pentagonal.

Material. Holotype lost; Neotype (Fleming, 1972) QGSF10898 (Neerkol Fm., Ridgelands 1 mile map ref. 265791); Others QGSF10891, 10897 (topotypes); NEUF4715E, 4719, 4700A (NUL9); NUF2377 (NUL472); numerous additional localities in the Stroud-Gloucester-Bulahdelah region, N.S.W.

Remarks. This most distinctive, very large species exhibits strong development of the operculum-like plate, with its variably placed boss-like projection, which closes the external aperture. The function of the projection on the plate cannot be determined from the external moulds available. It is considered to represent either a spine on the surface or a tube-like extension through the plate.

A. cincta differs from all other species described in this paper in possessing a very high, bladed, nodeless carina which separates the two rows of apertures on each

branch. In this respect, the inclusion of *A. cincta* in this paper is somewhat anomalous except for the apertural development which is considered to be its most significant feature.

Fleming (1966) placed *A. cincta* in his subgenus *Fenestella (Bajoola)*, which was defined to include species of *Fenestella* with strong nodeless carinae. Detailed comparison of the type species *F. (Bajoola) capellae* Fleming with the present species reveals a number of dissimilarities which would suggest that the grouping is possibly inappropriate. Significant differences in the structure of the carina and of the zooecial apertures and chambers, form the basis upon which the grouping has not been perpetuated. Other Early Carboniferous species (*F. roucheli* Crockford, *F. propinqua* de Koninck and *F. brownei* Roberts) have much more in common with the type species and may possibly be grouped with it at some future date.

A. cincta remains a solitary form without obvious affinity to any other species known to the writer. No useful comparisons can be offered from the literature at this stage.

Stratigraphy. A. cincta is widely found associated with the *Levipustula levis* zone. Its occurrence has been reported in Queensland from the Stanwell district (Crockford, 1949; Fleming, 1972) and the Yarrol district (Maxwell, 1964) in beds equated to various levels in the Neerkol Formation. New South Wales material has been described from Booral (Campbell, 1961) and has been found in the present study in a number of other localities in the Stroud-Gloucester-Bulahdelah region.

Australofenestella (?) keepitensis sp.nov.
Fig. 4, 1-3

1963 *Fenestella* sp.1. Campbell & Engel, pp.67-68, pl.1, figs. 4-5.

Diagnosis. Coarse, irregular fenestrate with wide, straight to slightly wavy, non-carinate branches forming a sub-oval to sub-rectangular mesh; nodes very large, widely spaced, irregularly distributed; apertures moderately large, not stabilized, situated low on branch sides; zooecia in two rows with a third, intermittently developed, central row of apertural-sized pits which are developed unrelated to branch bifurcations; zooecial bases large irregularly pentagonal in lateral rows and rhomboidal in the central row when developed.

Description. Zoarium: Expanding fragment of unknown orientation; maximum radius 65mm. *Obverse surface:* (a) *Branches.* Wide (m. BW 0.46mm), straight to slightly wavy with gently radiating arrangement; branch cross section rounded; ornament of fine pustulose striations obscured by secondary overgrowth. (b) *Dissepiments.* Wide (m. DW 0.42mm); branch junctions rounded to sub-rounded; situated below branch level; no ornament observed. (c) *Fenestrules.* Sub-rectangular to sub-oval; irregular mesh of long, wide fenestrules (m. FL 2.61mm; m. FW 1.10mm). (d) *Carina.* Absent; some low ridging occurs between nodes. (e) *Nodes.* Very large, prominent oval-based, round nodes (basal diameter 0.25-0.4mm); medium to distant spacing (m. N-N 0.49mm); node arrangement extremely irregular, varying from a central row, to a zigzag pattern, to a few cases of two nodes being placed alongside each other; nodal variation is irregular without relationship to branch bifurcations. (f) *Zooecial apertures.* Medium to large, circular (m. ZD 0.16mm); surrounded by low peristome, best developed on the fenestrular rim; apertures in two unstabilized rows situated low on branch sides where the apertures face into the fenestrule; apertures distantly spaced (m. Z-Z 0.47mm) with from five to six zooecia per fenestrule (m. Z/F 5.6); irregularly developed short rows of aperture-like pits occur along the centre line of some branches. Development is unrelated to branch bifurcations but the branches show some thickening in the region

of these extra rows. The pits are located between nodes and represent the brief, intermittent development of a third row of apertures.

Reverse surface: (a) *Form.* Irregular branches, varying from straight to zigzag in an anastomosing format; dissepiments equal in dimension to, and level with, branches; surface smooth. (b) *Zooecial bases.* Large, irregular, pentagonal in lateral rows and rhomboidal where a third row is developed.

Material. Holotype NEUF7466A/B (NEUL318 — Swaines Gully, Werrie Syncline).

Remarks. Evidence that the irregular central occurrence of small pits represents additional apertural development comes from the observation of three rows of zooecial chambers in some parts of the zoarium. Peristomal development is very weak on these central apertures.

The distribution of nodes and the erratic development of a third central row of apertures together with the absence of a central carina make it very unlikely that this species belongs to *Fenestella* Lonsdale. Although zigzag nodes are a feature of the subgenus *F. (Minilya)* Crockford, the nature of their development in the present species prevents any viable comparison being made.

No other species in the literature at present available can be usefully compared with *A.* (?) *keepitensis* which can only be dubiously assigned to this genus.

Stratigraphy. The species is known only from the Tulcumba Sandstone where it is associated with a *Spirifer sol* assemblage of early Tournaisian age.

Comparative Grouping of Species

Tables 1 and 2 detail the descriptive and statistical aspects of all the species/subspecies described in this paper.

Multi-rowed species. Stable, unifying features which justify the grouping of the multi-rowed species adopted in this paper include: (a) Apertures of large size, and medium to distant spacing, all of which bear a wide, low, peristomal collar which may be entire, or horseshoe-shaped with a proximal opening. All apertures bear a transverse plate or operculum and this plate carries a raised spine or boss-like projection, the position of which is usually central, but can be eccentrically placed; (b) Straight, wide to very wide branches of oval to flattened cross-section. Most species bear moderate to very strong development of distinctive, pustulose ribbing. All species lack a central carina having at most a low, internodal rise of very poor development; (c) Nodes are generally absent from the group but where developed are located on the proximo-central rim of an aperture in any zooecial row. In two species (*Australopolypora rawdonensis* and *Australopolypora altinodosa*), the obverse surface bears large, widely-spaced spines of presumed attachment significance because of their robust construction and lack of outward termination.

Some species exhibit a greater degree of similarity than others and the following discussion relates to these forms:

(1) *Australopolypora rawdonensis* and *Australopolypora palenensis.* These two species have the coarsest mesh of the multi-rowed species with a fenestrule length close to 3mm and a width of about 1.3mm. From the reverse, the form, ornament and zooecial bases are very similar. The major distinction lies in the position, form, and spacing of the zooecial apertures.

Australopolypora rawdonensis has horseshoe-shaped peristomes surrounding oval apertures which are placed in a fan-like arrangement. Central apertures have their long axis parallel to the branch length whereas the side apertures are inclined at 45 degrees to the length. By contrast, *Australopolypora palenensis* has apertures which are distally inclined to the branch surface, having the proximal

TABLE 1

A descriptive comparison of the important morphological features of the fenestrate mesh of all species of *Australopolypora* gen.nov. and *Australofenestella* gen.nov. described in this paper.

Genus	Species		FL mm	FW mm	BW mm	DW mm	ZD mm	Z-Z mm	N-N mm	Nº	F/10	B/10	Z/5	Z/F
AUSTRALOPOLYPORA	*rawdanensis*	x̄	2·71	1·24	0·56	0·16	0·17	0·37	0·87	140	3·7	8·2	13·5	7·3
		s	*0·558*	*0·212*	*0·092*	*0·043*	*0·015*	*0·034*	-					
		O.R.	1·20-4·40	0·88-1·92	0·34-0·80	0·10-0·32	0·12-0·20	0·32-0·49	0·62-1·14					
	palenensis	x̄	3·11	1·37	0·60	0·23	0·14	0·48		100	3·2	7·3	10·4	6·4
		s	*0·473*	*0·215*	*0·121*	*0·065*	*0·013*	*0·056*	—					
		O R	2·08-4·40	1·00-2·12	0·44-1·00	0·14-0·40	0·12-0·18	0·38-0·62						
	altinodosa	x̄	1·75	0·93	0·46	0·17	0·20	0·49	0·90	20	5·7	10·7	10·2	3·6
		O.R.	1·40-2·10	0·66-1·10	0·40-0·54	0·14-0·24	0·18-0·22	0·40-0·60	0·42-1·26					
	neerkolensis	x̄	1·74	1·10	0·64	0·27	0·20	0·44	1·00	260	6·2	10·1	12·4	4·3
		s	*0·205*	*0·205*	*0·130*	*0·091*	*0·025*	*0·060*	-					
		O.R.	1·14-2·30	0·64-1·80	0·36-1·16	0·12-0·52	0·16-0·28	0·30-0·62	0·72-1·20					
	scalpta	x̄	1·56	1·14	0·86	0·74	0·23	0·41	–	20	6·4	8·7	12·2	3·8
		O R	1·20-1·84	0·88-1·60	0·60-1·16	0·52-1·12	0·20-0·24	0·34-0·56						
	keppelensis keppelensis	x̄	1·01	0·92	0·50	0·14	0·16	0·33	rare	40	9·9	10·9	15·1	3·1
		s	*0·064*	*0·141*	*0·057*	*0·012*	*0·014*	*0·039*						
		OR	0·90-1·14	0·70-1·20	0·40-0·60	0·12-0·16	0·12-0·18	0·28-0·40						
	keppelensis parvula	x̄	0·83	0·64	0·41	0·23	0·15	0·26	present	40	12·0	15·6	19·3	3·2
		s	*0·062*	*0·072*	*0·058*	*0·030*	*0·013*	*0·030*						
		O R	0·68-0·95	0·50-0·84	0·32-0·60	0·20-0·30	0·12-0·18	0·22-0·32						
AUSTRALOFENESTELLA	*brookeri*	x̄	1·49	0·72	0·33	0·17	0·15	0·29	0·71	20	6·7	13·9	17·2	5·1
		O R	1·10-1·72	0·60-0·90	0·28-0·38	0·12-0·20	0·14-0·18	0·26-0·32	0·54-0·90					
	stroudensis minuta	x̄	1·37	0·72	0·29	0·08	0·17	0·30	0·44	20	7·3	13·9	16·8	4·6
		O R	0·56-1·94	0·50-0·92	0·26-0·34	0·04-0·12	0·14-0·18	0·26-0·34	0·28-0·60					
	stroudensis stroudensis	x̄	1·91	0·97	0·45	0·17	0·20	0·43	0·60	80	5·2	10·3	11·8	4·5
		s	*0·152*	*0·123*	*0·048*	*0·026*	*0·020*	*0·063*	*0·086*					
		O R	1·64-2·40	0·70-1·30	0·34-0·56	0·12-0·22	0·16-0·24	0·32-0·54	0·42-0·72					
	trevallynensis	x̄	1·57	0·73	0·30	0·15	0·14	0·31	0·66	100	6·4	13·8	16·2	5·1
		s	*0·218*	*0·127*	*0·035*	*0·029*	*0·017*	*0·025*	*0·081*					
		O R	0·76-2·30	0·46-1·00	0·22-0·38	0·08-0·22	0·10-0·20	0·26-0·38	0·46-0·84					
	malchi	x̄	1·63	0·91	0·40	0·16	0·14	0·42	0·81	160	6·2	11·1	12·2	4·0
		s	*0·252*	*0·189*	*0·073*	*0·045*	*0·015*	*0·056*	*0·120*					
		O R	1·12-2·26	0·38-1·40	0·24-0·64	0·08-0·28	0·10-0·16	0·32-0·56	0·44-1·12					
	macleayensis	x̄	2·62	1·04	0·47	0·18	0·15	0·43	1·10	60	3·8	9·8	11·6	6·1
		s	*0·339*	*0·223*	*0·066*	*0·041*	*0·017*	*0·047*	*0·193*					
		O R	2·08-3·92	0·56-1·66	0·32-0·60	0·12-0·30	0·12-0·18	0·34-0·54	0·56-1·80					
	cincta	x̄	3·39	1·23	0·55	0·19	0·19	0·49		120	3·1	8·2	10·5	7·0
		s	*1·136*	*0·267*	*0·082*	*0·037*	*0·019*	*0·075*	—					
		O R	1·60-6·90	0·70-2·04	0·40-0·78	0·12-0·30	0·16-0·24	0·30-0·66						
	(?) keepitensis	x̄	2·61	1·10	0·46	0·42	0·16	0·47	0·49	20	3·8	9·1	10·8	5·6
		O R	2·16-3·28	0·76-1·48	0·36-0·56	0·28-0·52	0·14-0·18	0·38-0·56	0·36-0·80					

rim of the peristome level with the surface and the distal rim depressed below branch level.

(2) *Australopolypora altinodosa* and *Australopolypora neerkolensis*. These two species have very close mesh dimensions. *A. altinodosa* has slightly narrower branches in keeping with its more extensive development of two rows of zooecia.

bear large attachment spines as noted above. In most respects, these species strong affinity with the number of zooecial rows being the principal distinc- Since *A. neerkolensis* has not been found at the one locality where *A. ıdosa* occurs, it is possible that the latter is just a local variant of *A. :olensis* at Booral, N.S.W. Lack of further material precludes a definite ion.

remaining taxa *Australopolypora scalpta* and *Australopolypora keppelensis ıla* are distinctive in their own right and exhibit no obvious grouping res.

TABLE 2

ıl summary of the mesh dimensions of all species of *Australopolypora* — *Australofenestella* n this paper. Species known only by a single specimen have only their means and observed ranges For explanations of abbreviations see Engel (1975, p.577).

ies	Mesh	Branch Width Form Profile	Fenestrules	Nodal Spacing & Size	Aperture Size & Spacing	Zooecial Rows post bif.	Zooecial Rows norm -al	Zooecial Rows pre bif	Zooecia per Fenestrule	Zooecial Bases	Special Features
ıensis	coarse, open, irregular	very wide, straight, round-oval	sub-rectangular to rectangular, long, wide	distant spines	large, oval, medium	3 / 3-4 / 4-5			5 to 9	oval, no overlap	horseshoe peristomes
ensis	coarse, open, irregular	very wide, straight, round-oval	sub-oval to rectangular, long, wide	–	medium, round, distant	2-3/3-4/4-5			5 to 9	oval, no overlap	distally inclined peristomes
dosa	medium, open, irregular	wide, straight, oval	sub-oval to rectangular, med. length/width	distant spines	large, round, distant	2 / 2-3 / 3			3 to 4	irregularly pentagonal rhomboidal	strong central ribbing
olensis	medium, open, regular	very wide, straight, oval	oval to sub rectangular, med. length/width	frequent, irregular	large, round, distant	2-3/ 3/4-5			3 to 5	elongate oval - rhomboidal	variable mesh
ta	medium, closed, regular	very wide, straight, oval	oval medium length, medium width	–	large, oval, medium	3 / 4 / 5			3 to 4	elongate hexagonal	depressed peristomes
lensis parvula	medium, even, regular	wide, straight, round-oval	oval to sub-oval, short length, medium width	frequent, irregular	large, round, close	2 / 3 / 4			2 to 3·5	irregularly pentagonal rhomboidal	horseshoe & complete peristomes
keri	medium, even, regular	narrow, straight, round	sub-oval to sub-rectangular, med length/width	distant, blunt, cones	large, round, close	2 / 2 / 3			4 to 6	triangular-irregularly pentagonal	blunt nodes peristomes
densis minuta	medium, open, regular	narrow, straight, round	sub-rectangular, medium length, medium width	medium regular small	large, round, close	2 / 2 / 3			4 to 6	irregularly pentagonal	conical nodes
densis ıudensis	coarse, open, regular	wide, straight, round	sub-rectangular, long, wide	vestigial	large, round, distant	2 / 2-3 / 3			4 to 5	irregularly pentagonal	weak nodes, no carina
lynensis	medium, open, irregular	medium, straight, triangular	sub-rectangular to rectangular, med. length/width	distant, regular, medium	medium, round, close	2 / 2 . 2-3			4 to 6	triang-trap -irregularly pentagonal	variable mesh
hi	medium, even, regular	medium, straight, triangular	rectangular to sub-rectangular, med. length/width	distant, regular, large	medium, round, distant	2 / 2 /2-3			3 to 5	elongate irregularly pentagonal	preservation distortion
eayensis	coarse, open, regular	wide, straight, triangular	sub-rectangular, long, wide	distant, irregular, bladed	medium, round, distant	2 / 2 /2-3			3 to 6·5	elongate irregularly pentagonal	preservation distortion
ta	coarse, open, irregular	very wide, straight, triangular	rectangular, very short to very long, wide	–	large, round, distant	2 / 2 / 2			3 to 12	very elongate irregularly pentagonal	very high nodeless carina
epitensis	coarse, open, irregular	wide, straight, round	sub-rectangular to sub-oval, long, wide	medium irregular large	large, round, distant	2 / 2-3 / 2			5 to 6	irregularly pentagonal -rhomboidal	erratic nodes & zooecia

CORRECTIONS:

Proc. Linn. Soc. N.S.W., 103 (3), pp. 166-167.

The tabulated matter of Table 1 has been printed under the heading for Table 2, and vice versa. The editor apologizes for failing to correct these printer's errors.

TABLE 1

A descriptive comparison of the important morphological features of the fenestrate mesh of all *Australopolypora* gen.nov. and *Australofenestella* gen.nov. described in this paper.

Genus	Species		FL mm	FW mm	BW mm	DW mm	ZD mm	Z-Z mm	N-N mm	Nº	F/10	B/1
AUSTRALOPOLYPORA	*rawdonensis*	x̄	2·71	1·24	0·56	0·16	0·17	0·37	0·87	140	3·7	8·2
		s	*0·558*	*0·212*	*0·092*	*0·043*	*0·015*	*0·034*	-			
		O.R.	1·20-4·40	0·88-1·92	0·34-0·80	0·10-0·32	0·12-0·20	0·32-0·49	0·62-1·14			
	palenensis	x̄	3·11	1·37	0·60	0·23	0·14	0·48		100	3·2	7·3
		s	*0·473*	*0·215*	*0·121*	*0·065*	*0·013*	*0·056*	—			
		O R	2·08-4·40	1·00-2·12	0·44-1·00	0·14-0·40	0·12-0·18	0·38-0·62				
	altinodosa	x̄	1·75	0·93	0·46	0·17	0·20	0·49	0·90	20	5·7	10·7
		O R	1·40-2·10	0·66-1·10	0·40-0·54	0·14-0·24	0·18-0·22	0·40-0·60	0·42-1·26			
	neerkolensis	x̄	1·74	1·10	0·64	0·27	0·20	0·44	1·00	260	6·2	10·1
		s	*0·205*	*0·205*	*0·130*	*0·091*	*0·025*	*0·060*	-			
		O.R.	1·14-2·30	0·64-1·80	0·36-1·16	0·12-0·52	0·16-0·28	0·30-0·62	0·72-1·20			
	scalpta	x̄	1·56	1·14	0·86	0·74	0·23	0·41	—	20	6·4	8·7
		O R	1·20-1·84	0·88-1·60	0·60-1·16	0·52-1·12	0·20-0·24	0·34-0·56				
	keppelensis keppelensis	x̄	1·01	0·92	0·50	0·14	0·16	0·33	rare	40	9·9	10·9
		s	*0·064*	*0·141*	*0·057*	*0·012*	*0·014*	*0·039*				
		OR	0·90-1·14	0·70-1·20	0·40-0·60	0·12-0·16	0·12-0·18	0·28-0·40				
	keppelensis parvula	x̄	0·83	0·64	0·41	0·23	0·15	0·26	present	40	12·0	15·6
		s	*0·062*	*0·072*	*0·058*	*0·030*	*0·013*	*0·030*				
		O R	0·68-0·95	0·50-0·84	0·32-0·60	0·20-0·30	0·12-0·18	0·22-0·32				
AUSTRALOFENESTELLA	*brookeri*	x̄	1·49	0·72	0·33	0·17	0·15	0·29	0·71	20	6·7	13·9
		OR	1·10-1·72	0·60-0·90	0·28-0·38	0·12-0·20	0·14-0·18	0·26-0·32	0·54-0·90			
	stroudensis minuta	x̄	1·37	0·72	0·29	0·08	0·17	0·30	0·44	20	7·3	13·9
		OR	0·56-1·94	0·50-0·92	0·26-0·34	0·04-0·12	0·14-0·18	0·26-0·34	0·28-0·60			
	stroudensis stroudensis	x̄	1·91	0·97	0·45	0·17	0·20	0·43	0·60	80	5·2	10·3
		s	*0·152*	*0·123*	*0·048*	*0·026*	*0·020*	*0·063*	*0·086*			
		OR	1·64-2·40	0·70-1·30	0·34-0·56	0·12-0·22	0·16-0·24	0·32-0·54	0·42-0·72			
	trevallynensis	x̄	1·57	0·73	0·30	0·15	0·14	0·31	0·66	100	6·4	13·8
		s	*0·218*	*0·127*	*0·035*	*0·029*	*0·017*	*0·025*	*0·081*			
		OR	0·76-2·30	0·46-1·00	0·22-0·38	0·08-0·22	0·10-0·20	0·26-0·38	0·46-0·84			
	malchi	x̄	1·63	0·91	0·40	0·16	0·14	0·42	0·81	160	6·2	11·1
		s	*0·252*	*0·189*	*0·073*	*0·045*	*0·015*	*0·056*	*0·120*			
		OR	1·12-2·26	0·38-1·40	0·24-0·64	0·08-0·28	0·10-0·16	0·32-0·56	0·44-1·12			
	macleayensis	x̄	2·62	1·04	0·47	0·18	0·15	0·43	1·10	60	3·8	9·8
		s	*0·339*	*0·223*	*0·066*	*0·041*	*0·017*	*0·047*	*0·193*			
		OR	2·08-3·92	0·56-1·66	0·32-0·60	0·12-0·30	0·12-0·18	0·34-0·54	0·56-1·80			
	cincta	x̄	3·39	1·23	0·55	0·19	0·19	0·49		120	3·1	8·2
		s	*1·136*	*0·267*	*0·082*	*0·037*	*0·019*	*0·075*	—			
		OR	1·60-6·90	0·70-2·04	0·40-0·78	0·12-0·30	0·16-0·24	0·30-0·66				
	(?) keepitensis	x̄	2·61	1·10	0·46	0·42	0·16	0·47	0·49	20	3·8	9·1
		OR	2·16-3·28	0·76-1·48	0·36-0·56	0·28-0·52	0·14-0·18	0·38-0·56	0·36-0·80			

rim of the peristome level with the surface and the distal rim depressed branch level.

(2) *Australopolypora altinodosa* and *Australopolypora neerkolensis*. The species have very close mesh dimensions. *A. altinodosa* has slightly na branches in keeping with its more extensive development of two rows of z

Both bear large attachment spines as noted above. In most respects, these species show strong affinity with the number of zooecial rows being the principal distinction. Since *A. neerkolensis* has not been found at the one locality where *A. altinodosa* occurs, it is possible that the latter is just a local variant of *A. neerkolensis* at Booral, N.S.W. Lack of further material precludes a definite decision.

(3) The remaining taxa *Australopolypora scalpta* and *Australopolypora keppelensis parvula* are distinctive in their own right and exhibit no obvious grouping features.

TABLE 2

A statistical summary of the mesh dimensions of all species of *Australopolypora — Australofenestella* described in this paper. Species known only by a single specimen have only their means and observed ranges recorded. For explanations of abbreviations see Engel (1975, p.577).

	Species	Mesh	Branch Width Form Profile	Fenestrules	Nodal Spacing & Size	Apertural Size & Spacing	Zooecial Rows post bif.	Zooecial Rows norm -al	Zooecial Rows pre bif	Zooecia per Fenestrule	Zooecial Bases	Special Features
AUSTRALOPOLYPORA	*rawdonensis*	coarse, open, irregular	very wide, straight; round-oval	sub-rectangular to rectangular; long; wide	distant spines	large; oval; medium	3 / 3-4 / 4-5			5 to 9	oval, no overlap	horseshoe peristomes
	palenensis	coarse; open; irregular	very wide, straight, round-oval	sub-oval to rectangular; long, wide	–	medium; round, distant	2-3/3-4/4-5			5 to 9	oval, no overlap	distally inclined peristomes
	altinodosa	medium, open, irregular	wide, straight, oval	sub-oval to rectangular, med. length/width	distant spines	large, round, distant	2 / 2-3 / 3			3 to 4	irregularly pentagonal rhomboidal	strong central ribbing
	neerkolensis	medium; open, regular	very wide, straight; oval	oval to sub rectangular med. length/width	frequent; irregular	large, round, distant	2-3/ 3/4-5			3 to 5	elongate oval - rhomboidal	variable mesh
	scalpta	medium, closed, regular	very wide, straight; oval	oval medium length, medium width	—	large, oval, medium	3 / 4 / 5			3 to 4	elongate hexagonal	depressed peristomes
	keppelensis parvula	medium, even, regular	wide, straight, round-oval	oval to sub-oval; short length, medium width	frequent; irregular	large, round, close	2 / 3 / 4			2 to 3.5	irregularly pentagonal rhomboidal	horseshoe & complete peristomes
AUSTRALOFENESTELLA	*brookeri*	medium, even, regular	narrow, straight, round	sub-oval to sub-rectangular; med. length/width	distant, blunt, cones	large, round, close	2 / 2 / 3			4 to 6	triangular-irregularly pentagonal	blunt nodes peristomes
	stroudensis minuta	medium; open, regular	narrow, straight, round	sub-rectangular; medium length, medium width	medium regular small	large, round, close	2 / 2 / 3			4 to 6	irregularly pentagonal	conical nodes
	stroudensis stroudensis	coarse, open, regular	wide, straight, round	sub-rectangular; long, wide	vestigial	large, round, distant	2 / 2-3 / 3			4 to 5	irregularly pentagonal	weak nodes, no carina
	trevallynensis	medium; open, irregular	medium, straight, triangular	sub-rectangular to rectangular, med. length/width	distant, regular; medium	medium, round, close	2 / 2 - 2-3			4 to 6	triang.-trap. -irregularly pentagonal	variable mesh
	malchi	medium, even, regular	medium, straight, triangular	rectangular to sub-rectangular; med. length/width	distant, regular; large	medium, round, distant	2 / 2 /2-3			3 to 5	elongate irregularly pentagonal	preservation distortion
	macleayensis	coarse, open, regular	wide, straight, triangular	sub-rectangular; long, wide	distant, irregular; bladed	medium, round; distant	2 / 2 /2-3			3 to 6-5	elongate irregularly pentagonal	preservation distortion
	cincta	coarse, open, irregular	very wide; straight, triangular	rectangular, very short to very long, wide	—	large, round, distant	2 / 2 / 2			3 to 12	very elongate irregularly pentagonal	very high nodeless carina
	(?)keepitensis	coarse, open, irregular	wide, straight, round	sub-rectangular to sub-oval, long, wide	medium irregular large	large, round, distant	2 / 2-3 / 2			5 to 6	irregularly pentagonal -rhomboidal	erratic nodes & zooecia

Two-rowed species. The inclusion of eight two-rowed species in this paper is based substantially upon their common development of large-sized apertures which are very similar to those of the multi-rowed species. In all cases, these apertures are closed by an operculum-like lid which bears an axial boss or elevated perforation.

In contrast to the multi-rowed, most of the two-rowed species have a regular central row of nodes, the exceptions to this being *Australofenestella cincta* which is nodeless and *Australofenestella (?) keepitensis* which displays very irregular nodal development. In addition, most species exhibit some carinal development although this aspect is highly variable within the group from almost no development to the very attenuated form of *A. cincta.*

Grouping of the two-rowed species is as follows:

(1) *Australofenestella brookeri, Australofenestella stroudensis minuta* and *Australofenestella s. stroudensis.* These three taxa form a developmental series throughout the duration of the Carboniferous interval. Principal variations include: (a) Nodes in *A. brookeri* are large, bluntly cone-shaped features arranged along a vague central ridge. In *A. s. minuta* the nodes are much smaller and in *A. s. stroudensis* they are very vague, blunt prominences of vestigial form. In all cases the carinal development is weak; (b) As noted above, the number of pre-bifurcation apertures in the third, central row increases in the younger species such that the generic assignment based upon the number of apertural rows becomes increasingly contentious; (c) Mesh variations, depicted in Tables 1 and 2, illustrate a continuing enlargement of the zoaria through geological time.

(2) *Australofenestella trevallynensis, Australofenestella malchi* and *Australofenestella macleayensis. A. trevallynensis* and *A. malchi* are two stratigraphically separated species which have a great deal in common. Mesh differences are small but consistently larger in the younger species *A. malchi.* In addition, *A. trevallynensis* has an irregular, crenulated mesh with weak carinal development, small nodes and closer apertures whereas in *A. malchi,* the mesh is regular and branches have well defined broad carinae which bear stronger nodes. Differences also exist in the position of onset of the third row of zooecia before bifurcation, in the reverse branching pattern and in the outline of the zooecial bases which are transitional in form between the two species.

A. macleayensis is a considerably larger species which continues the trends evident in *A. malchi.* The former species exhibits much greater fenestrule length, branch width, and nodal spacing. However since there is no material which presently bridges the dimension gap between these two species, both taxa have been retained.

In summary, all three species share a similar morphology which is emphasized by the common presence of the strong apertures with a distinctive covering.

Stratigraphic Summary

Detailed stratigraphic distribution of each species is included with the respective descriptions. They are also illustrated in Fig. 6. From these data, some further conclusions are of significance.

The first record of the multi-rowed species of *Australopolypora* in eastern Australian strata appears to be that of *Australopolypora rawdonensis* from the late Visean *Rhipidomella fortimuscula* assemblage zone. Phillips Ross (1961) makes no mention of multi-rowed species in her summary of the Ordovician-Silurian-Devonian Bryozoa of Australia, and the present study has failed to reveal any older Carboniferous forms. The first multi-rowed fenestrate to appear in the record belongs to *Septatopora* which therefore just slightly predates the first australopolyporid. Together, they constitute